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ORAL SURGERY
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OPERATIVE ORAL SURGERY

ORAL SURGERY AT THE CROSSROADS—WHICH DIRECTION?

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THE growth and success of an organization depend largely upon the reason for its existence and upon the wisdom and farsightedness of those who constitute the membership. We are gathered here this evening to honor the memory of a man who could look to the future and foster within the younger members of our profession a desire to further their knowledge of oral pathology as a basis upon which to build their clinical practice. The late Sir William Osler who, prior to being knighted, practiced medicine in Philadelphia from 1884 to 1889 and served as professor of clinical medicine at the university of Pennsylvania, is credited with the saying: "As is our pathology, so is our practice." The New York Institute of Clinical Oral Pathology over the past twenty-seven years, and under the continued influence and wise council of Dr. Theodor Blum, has done much to promote interest in the basic sciences as applied to dental practice. The pattern set by this organization has encouraged other dental men throughout the country to form similar study groups for the advancement of basic understanding so necessary for a successful practice.

During the past few weeks the dental profession in America celebrated 100 years of existence of the parent organization, the American Dental Association, and I am sure that all of us who had the good fortune to attend the various sessions covering the progress made by dentistry during the past 100 years could not help but notice the changing concept of dental practice in keeping with the ever-expanding horizon of dental education. As we view this changing picture of dental education and the resulting expansion of practice, we can readily visualize that the scope of certain areas of practice has likewise expanded and demands of the dentist his undivided attention. No one person can develop within himself and become proficient in all of the

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rapidly accumulating knowledge and technical advances that present-day practice demands. It is the responsibility of dental educators and those who have established themselves in successful practices to assume leadership in charting the future course of our profession. We of the older generation owe to the young men entering the profession guidance and encouragement, for without vision, whether right or wrong, the future would be dark.

This brings us to a consideration of specialties within our profession—at the present time a somewhat knotty problem with many facets and complexities of a controversial nature. Dentistry, as I view the position it occupies in the health field, has but two major specialties—oral surgery and orthodontia. The present trend in some quarters toward the fragmentation of dentistry is, I feel, to be deplored. Other than oral surgery and orthodontia, all other so-called specialties are, in my opinion, well within the domain of the general dentist, who may devote the greater portion of his time to one particular phase of dentistry but not limit himself exclusively to that branch. In so stating my position in regard to specialists, I do not mean to imply that the general dentist who has had adequate training should not be recognized as capable of caring for certain uncomplicated routine surgical or orthodontic procedures. This should be his prerogative if he so desires. If oral surgery is to be practiced in its broadest scope, however, it becomes a full-time job.

Before discussing some of the problems facing oral surgery as a branch of dentistry, let us briefly view the advanced educational program that the prospective oral surgeon is being called upon to complete in order to be eligible to take examinations for certification by the American Board of Oral Surgery. A minimum of five years' exclusive study of oral surgery, over and above that received on the undergraduate level, is required. This consists of one year of basic science on the graduate level, two years of an oral surgical residency in an approved general hospital, and two years of clinical practice. Naturally, the student about to undertake such a period of advanced study leading to a graduate degree is concerned as to what limitations, if any, he will encounter as he starts into practice as an oral surgeon. The American Board of Oral Surgery has stated the scope of oral surgery as follows: "The scope of the specialty of oral surgery shall include the diagnosis, the surgical and adjunctive treatment of the diseases, injuries, and defects of the human jaws and associated structures within the limits of the professional qualifications and training of the individual practitioner and within the limits of agreements made at the local level by those concerned with the total health care of the patient." As one studies this statement, it will be seen to follow closely the rules governing medical staff appointments and medical practice assignments in well-regulated general hospitals. As dentistry continues to make progress and embrace a wider horizon of practice, various extraneous situations may be expected to develop and thrust themselves into the field of dental education, with the result that oral surgery as a dental specialty finds itself, in this year of 1959, very much at the crossroads as to which direction the training and education of a dentist as an oral surgeon should follow.

In most states the legal status of a dentist is well defined and offers a liberal scope of practice. Unfortunately, however, there are still some states whose dental practice acts, written many years ago, are no longer sufficient in scope to meet present-day thinking and practice, which has rightly gone beyond the thinking of fifty years ago. If dental practice is to be standardized throughout the country, the dental practice acts of some states need to be revised and brought up to date.

Much of the recent confusion and, at times, bitterness and hard feelings which have occurred in some sections of the country regarding the place of a dentist on a hospital staff has been precipitated by the Commission on Accreditation of Hospitals. It is most unfortunate that the Commission has permitted itself to be placed in this embarrassing position which, in turn, has embarrassed and angered dentists. The purpose of the Commission on Accreditation of Hospitals is to guide and aid in the raising of standards of hospital practice. In this regard, I feel that the Commission, with a few exceptions, is trying to do a good job. Through either lack of understanding or disinterest, however, it has failed to give dentistry and the dental specialty of oral surgery a proper evaluation as a health agency closely allied to medicine and one having the same high ideals as medicine in the care of the sick and injured. Dentistry, in whole or in part, belongs in a well-conducted general hospital and should be accorded status on the hospital staff comparable to that of the various other departments or divisions in medicine. The broad field of medical practice in our hospitals depends upon a competent, well-trained staff of physicians working toward the common goal of patient care. Medicine, however, in its constant progress and expansion of practice, is no longer self-reliant but must depend upon many and varied allied professions as supporting agencies in promoting health and longevity. Radical changes in medicine are constantly taking place and the one-time, conservative, all-embracing concept of medical practice centered around the medical degree is slowly but steadily giving way to a broader viewpoint of what constitutes care of the patient. Dentistry, including the dental specialty of oral surgery, is so closely related to medicine in everyday practice that the two professions are almost as one in their reasons for existence, even though the training of each has taken place in different schools. Had medicine recognized this close relationship over 100 years ago, much of the present-day misunderstanding on the part of certain segments of medicine would have been avoided. However, the die has been cast. Dentistry, as an autonomous profession, has advanced to its present high standard by its own effort and must, of necessity, retain its own educational program.

In some hospitals the medical staff and the hospital administrator, due to recommendations made by the Commission on Accreditation of Hospitals, are somewhat confused as to the position which an oral surgeon, whose basic training has been that of a dentist, should occupy in the hospital family. This unfortunate state of affairs should never have occurred and could very readily be corrected if the Commission on Accreditation of Hospitals would rewrite its section on dental service to be in keeping with the scope of oral

surgery as outlined by the American Board of Oral Surgery, working under the direction of the Council on Dental Education of the American Dental Association. Fortunately, the problem which the Commission on Accreditation of Hospitals has created does not exist in all hospitals. Where a harmonious relationship between medicine and dentistry exists in most of our hospitals, it does so because the members of the oral surgery staff have been evaluated as to their qualifications and competency on the same local level as are members of the medical staff. In such hospitals the admission of the oral surgery patient, his physical evaluation, and his discharge are the responsibilities of the oral surgeon or oral surgery staff. With the advanced training now available, the oral surgeon is perfectly capable and within his legal right in carrying through these procedures. This relieves the medical service in a busy hospital of many routine examinations that are not of particular interest to the physician. Should any question concerning a problem within the domain of medicine arise during the physical examination of a patient admitted for an oral surgery procedure, then medical consultation should be requested and obtained. In such cases the re-evaluation of the patient and the recommendation of the physician should, after consultation with the oral surgeon, determine the procedure to be followed. This is true cooperation between medicine and dentistry, and it works quite smoothly and most satisfactorily in many of our large teaching hospitals. The dogmatic statement that only a doctor of medicine should admit and discharge hospital dental patients and that only a doctor of medicine is capable of writing a history and evaluating the physical condition of a patient for oral surgery just does not hold water. Everyday office practice of oral surgery requires of the oral surgeon the taking of a history and the evaluation of the patient. Failure to do so could lead to justifiable criticism, if not legal action. Since this is a recognized procedure for the ambulatory office patient, why should it be different for the same patient who enters the portals of a hospital? In its effort to raise the standards of hospital practice, the Commission is faced by many problems which are of greater import than those related to dentistry, and I feel that in this regard it is doing a good job. Its attitude regarding the place of oral surgery in hospital practice, however, is entirely out of line with present-day thinking and has tended to weaken in a few areas the cordial relationship that has existed over the years between medicine and dentistry. It seems to me that the Commission, in attempting to regulate what constitutes dental practice, is certainly going beyond its primary reason for existence.

As we continue the study of which direction the future practice of oral surgery will take and often face embarrassing statements by those who would belittle dental training, we must not overlook some of the shortcomings that may exist within our own ranks and which may, at times, lead to well-deserved criticism. Where such shortcomings do exist and are recognized, they should be corrected by dentists themselves.

The advent of Blue Cross, Blue Shield, and other insurance programs has brought an increasing demand on the part of many general dentists for hospital appointments or privileges. Many dentists were not interested in

hospitalizing their patients prior to the development of various insurance programs now offered to the public. They cared for patients requiring routine minor surgical procedures in their offices or referred them to oral surgeons in their locality. Insurance programs providing payment only for patients admitted to a hospital have brought about a demand for unnecessary bed occupancy by patients who could be adequately cared for on an ambulatory basis as such patients have always been cared for over the years. With this influx of men, many of whom are untrained in hospital procedures and have one eye on the dollar sign, it can be understood that criticism has frequently been directed at the dental profession as a whole. This situation is a most unfortunate one in so far as insurance plans do not differentiate between the well-trained, experienced oral surgeon and those who are poorly qualified. To go further, some of the insurance programs offered to the public take the very narrow-minded attitude that only a doctor of medicine should be compensated for treatment of a hospitalized dental patient, even though he has not been trained in this particular field. This is a discrimination of the worst kind between the professions. It embarrasses both physicians and dentists. The patient is in the middle and wonders why. It is the sort of thing that encourages dishonesty by means of a subterfuge. The code of ethics of both medicine and dentistry is opposed to such procedures, and steps to eliminate this discrimination where it exists are long overdue.

Another angle facing the well-trained oral surgeon is the loosely assumed title "oral surgeon." Too many general practitioners of dentistry and some dentists who limit their practice entirely to exodontia use the title of oral surgeon and, by so doing, create the impression of being capable in all branches of oral surgery. In reality, their work is confined to tooth extraction and the most minor type of surgical procedures, which they may do exceptionally well. They are not, however, by training capable of practicing oral surgery as we understand it today. As a result, physicians and the public may be excused for considering tooth extraction as the all-encompassing area of oral surgery while the broader scope of practice, such as caring for complicated maxillary fractures, deep infections, oncology problems, correction of deformities, etc., is considered within the domain of someone who has a medical degree, even though he may not possess any training in oral surgery. This attitude of some dentists in assuming the title of oral surgeon when they are totally incapable of practicing full-scale oral surgery encourages certain fringe areas in the medical field to encroach into the domain of dental practice. It is a discouraging but not a hopeless situation for the young, well-trained oral surgeon to face. In areas where a capable, well-trained oral surgeon is available, the encroachment of medical men into the field of oral surgery, for which they have not been trained, should not pose too serious a problem, provided the general dentists of that area are broad-minded enough and willing to support a competent member of their own profession. The results of patient care will eventually determine the final outcome of this problem where it exists. The general practitioner, who is the family dentist, is the backbone of the profession. It is the responsibility of dentistry as a

whole, working through the Council on Dental Education of the American Dental Association, to foster and encourage advanced education in our profession. In turn, dentists should support their own specialists who have prepared themselves by adequate study to be so recognized. The general dentist, by so doing, will do much to keep oral surgery strictly within the dental field. He will also enhance his own position as a member of a profession that is steadily growing in importance, and in no way will he lessen his stature as a dentist. Jealousy should have no place in the life of a true professional man.

Correction of these many problems is of paramount concern to the dental profession at large and of vital interest to our young dental graduates who are enthusiastically seeking advanced study and training in oral surgery and who look to older practitioners not only for leadership but for guidance and encouragement commensurate with their training. These issues which I have enumerated cannot be sidestepped. They must be faced honestly and solved by a concerted effort on the part of the dental profession to educate all concerned in placing dentistry and its specialty of oral surgery in their proper perspective. We who are proud of our heritage must fearlessly support the changing horizon of dental practice and encourage the dentists of the future to be better qualified than we, in our time, have been.

As a teacher of both undergraduate and graduate students, I am frequently asked the question: "Is it necessary to have a degree in medicine to practice oral surgery?" The answer is: "No." The dentist who later obtains a degree in medicine will find certain extraneous advantages that he otherwise might not enjoy, but the study of medicine as such will not qualify the holder of the M.D. degree to practice oral surgery. The period of formal graduate training in oral surgery will still be required as a prerequisite to certification, even for persons with both a dental and a medical degree.

Not infrequently the dentist who studies medicine finds some branch of medicine of greater interest than a dental specialty and prepares himself accordingly to practice as a physician. This, of course, is a loss to dentistry and a gain for medicine. It is estimated that approximately 50 per cent of double-degree holders eventually become medical practitioners. The length of training and the cost of obtaining both a dental and a medical education plus the time required for study and training over and above the undergraduate level will, I feel, make it prohibitive for all but a few to follow such a program. Here the law of supply and demand will, to a large extent, determine the direction of an educational program. There are not now, and I seriously doubt if there will be in the future, enough double-degree practitioners to care adequately for all the necessary oral surgery that the public has come to expect and demand. Consequently, we must look to the continuation of graduate studies on a high plane for the dentist who desires to qualify himself properly as an oral surgeon. Excellent, well-planned courses are now available in various universities, and more and more hospitals are offering

organized residencies in oral surgery. I feel sure that the number of residencies will continue to increase as the number of graduate students who, upon completing their training, become established as oral surgeons throughout the country increases.

While dentistry is still in a transitional stage, as are other professions, one cannot help but realize, judging from the recent centennial meeting held here in New York, that our profession has reached maturity. Oral surgery, its oldest specialty, has likewise developed along broad and expanding lines to a place commanding respect and, at times, envy as an important health agency. The future of this branch of dentistry and the direction that it will take will depend largely on the continuation of a high-level educational program which correctly stresses the basic sciences in developing sound surgical judgment as related to clinical practice. Technical skill, of course, must be developed as in all branches of surgery, but principles rather than techniques must be emphasized in the fundamental training of the future oral surgeon, whose expanding field of practice carries an increase in responsibility.

The dental profession, as a whole, must support the ever-increasing need for advanced education in order to prepare adequately all dental practitioners to meet their responsibility in the prevention of disease, the detection and evaluation of early lesions, and the curing of diseased conditions. The specialty of oral surgery, dating back to the days of Garretson in 1864, has bestowed upon dentistry a heritage not lightly to be cast aside or forgotten. It is a birthright of which all dentists can and should be proud and one that must not be surrendered, no matter how much political pressure or agitation by envious fringe groups may be applied in an effort to limit the scope of the oldest dental specialty being practiced by qualified dentists. We must retain this branch of dentistry within the dental profession, where it was conceived and where it has been nourished and developed over the years. Its survial will depend upon dentists.

269 S. 19TH ST.

BRANCHIAL CARCINOMA

Report of a Case

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BRANCHIAL carcinoma is an infrequent tumor, arising from remnants of branchial cleft epithelium or a branchial cyst. The presence of such a tumor in close relation to the oropharynx appears to be of rare occurrence. Therefore, the following case is reported.

CASE REPORT

A female patient, aged 50 years, was referred by her dental surgeon for advice and treatment of a painless swelling situated in the posterior part of the mouth just medial to the anterior border of the left ascending ramus of the mandible.

The patient first became aware of its presence three years previously. It had gradually increased in size. It was painless and in no way interfered with mastication or deglutition.

Examination.—Medial to the ascending ramus of the left mandible and lateral to the pterygomandibular ligament at a level of about ½ inch above the mandibular occlusal plane, a firm, smooth swelling could be palpated. It was painless to palpation, and the overlying mucosa was freely movable and of normal appearance. No other abnormalities were present within the mouth. No lymph nodes were palpable in the left submandibular or cervical regions, and a general physical examination revealed no abnormalities.

The patient was referred for radiographs of the left mandible, but these did not show any pathology in the horizontal or ascending rami.

The patient was hospitalized for exploration and, if possible, removal of the swelling.

Operation.—Under a general anesthetic, a vertical incision was made over the anterior border of the ascending ramus of the left mandible. The tissues were retracted medially and, by blunt dissection, an encapsulated, spherical mass approximately 1 inch in diameter was identified lying medial to the left ascending ramus and lateral to the anterior fibers of the medial pterygoid muscle. The tumor was quite superficial, and the overlying oral mucosa was in no way attached to it. There was, however, a fibrous pedicle arising from the upper part of the tumor and passing in an upward and posterior direction. It was impossible to identify the termination of this pedicle; therefore, it was clamped and divided as far from the tumor as practical. The tumor was quite easily shelled out of its bed, and the soft tissues were replaced and sutured.

Pathologic Examination.—At the time of the operation it was assumed that this tumor was a cyst, and it was sent for histopathologic examination to confirm this diagnosis.

Macroscopic examination of the tumor showed it to be spherical in shape and surrounded by a fibrouslike capsule. It was easily cut in half, revealing a fairly thick fibrous sac containing a large amount of thick yellowish fluid in which a few cholesterol crystals were evident.

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The pathologist reported that the naked-eye appearance was that of a cyst, 2 cm. in diameter. Microscopic examination, however, revealed changes typical of a squamous-cell carcinoma (Fig. 1).

Healing following the operation was uneventful.

To eliminate the possibility of this tumor being a metastasis from a primary lesion elsewhere, the patient was subjected to a further general examination which proved negative. Therefore, it was assumed that the tumor in question was the primary site of the disease, and the area from which it was removed was subjected to a course of x-ray therapy.

When the patient was seen again twelve months later, there was no evidence of recurrence of the tumor and the patient's general condition was extremely good.

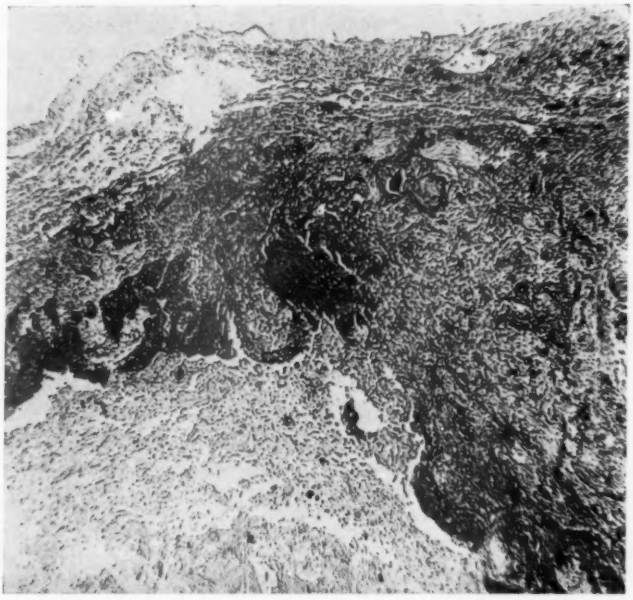

Fig. 1.

COMMENTS

The site and histopathology of this tumor are extremely interesting. The presence of a cyst in such a position leads one to believe that it developed from enclosed epithelial tissues. It is well known that a branchial cyst in the neck may result from the inclusion of epithelial cells during the obliteration of the branchial clefts. These cell inclusions may be derived from the external cleft membrane (the future skin) or the internal membrane (the future lining of the pharynx). If these cells grow, they form a branchial cyst lined by either squamous or columnar epithelium.

Clinically, a branchial cyst becomes obvious between the tenth and twenty-first years of life, although occasionally they do not become apparent until much later. They are more common in males than in females, and they are

usually situated on the left side of the neck. They are most commonly derived from the third branchial cleft and lie between the anterior border of the sternomastoid muscle and the lateral ala of the thyroid cartilage. Rarely, a branchial cyst arises from the second cleft when it is situated higher in the neck in relation to the mastoid process and the jaw, and it may project into the mouth. Occasionally, a cyst at this level is attached by a fibrous prolongation to the mastoid or styloid process.

The position of the cyst in the case reported here suggests that it was derived from the second branchial cleft. During its removal a fibrous pedicle was encountered which passed in an upward and posterior direction into the deeper tissues. It would appear that this pedicle was, indeed, a fibrous prolongation to the mastoid or styloid process which is sometimes encountered with these cysts.

The chief complication of a branchial cyst is that the epithelial lining may undergo malignant changes resulting in a squamous-cell carcinoma, as did occur in the case reported. Such changes usually appear in the elderly, and they take on rapid growth, when, according to Handfield-Jones and Porritt,[1] they are difficult to remove successfully. Metastases from such neoplasms, fortunately occur late.

Before a diagnosis of branchial carcinoma can be made, it is essential to exclude the possibility of the tumor being secondary to a primary lesion elsewhere. In the case presented here, the evidence suggests that originally a branchial cyst developed and at a later date the epithelial lining underwent malignant changes.

The author wishes to thank Mr. W. C. Mellor, F.D.S.R.C.S. (Eng.), Consultant Oral Surgeon, Crumpsall Hospital, Manchester, for permission to publish this case and Miss J. Perry of the Department of Medical Illustration for the production of the illustration.

REFERENCE

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MYXOMA OF LEFT MAXILLA

Report of a Case

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PATIENT R. K., a 37-year-old white woman, was admitted to the Elizabeth Steel Magee Hospital in Pittsburgh, Pennsylvania, on Dec. 6, 1956, for the removal of an impacted, unerupted maxillary left third molar.

History.—The patient first noticed swelling and tenderness in the left posterior area of the maxilla in December, 1952. She reported this to her dentist, who neglected to radiograph the area. He stated that the maxillary left second molar was "pyorrheic" and extracted the tooth. The patient recovered uneventfully, except that she noticed recurrent swelling and soreness of the area. On Nov. 11, 1956, the swelling in the area greatly increased; extreme local pain was present, as well as pain on swallowing. Antibiotic treatment effected a recovery. Radiographs were taken of the area, and an impacted, unerupted maxillary left third molar was discovered. An area of irregular radiopaque and radiolucent patterns was noted anterior to the unerupted, impacted third molar (Fig. 1). The patient was referred for surgery.

Examination.—There were several swollen left submaxillary lymph nodes. Intraorally, the left maxillary molar area was expanded to the size of a walnut. The muocsal tissue appeared normal and light pink in color. The preoperative diagnosis was "impacted left maxillary third molar and a central tumor anterior and superior to this tooth." It was believed that the tumor might be a fibromyxoma or a central giant-cell tumor, with chronic secondary infection.

Surgical excision of the impacted, unerupted maxillary left third molar and of the tumor was deemed necessary.

Operation.—On Dec. 7, 1956, following induction of Pentothal sodium and nitrous oxide and oxygen anesthesia, a wide mucoperiosteal flap over the area was reflected with a periosteal elevator, exposing thin expanded cortical bone. Enough buccal bone was removed with mallet, chisel, and rongeurs to permit good visualization of the maxillary left third molar. The molar was easily removed with elevators. A cartilaginous, whitish, semifirm tumor was noted anterior to the third molar alveolus. The tumor was fully exposed by the removal of the thin cortical bone with which it was covered. Clinically, the tumor was considered to be a fibromyxoma. It was grasped with Allis forceps and

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enucleated with a periosteal elevator. The tumor extended to the floor of the maxillary sinus but not into it, although the intact lining membrane of the sinus was exposed. The tumor was approximately 3 cm. long and 2 cm. wide (Fig. 2). The alveolus of the third molar was débrided; the flap was re-

Fig. 1.—Note area of irregular radiopaque and radiolucent patterns anterior to the unerupted impacted third molar.

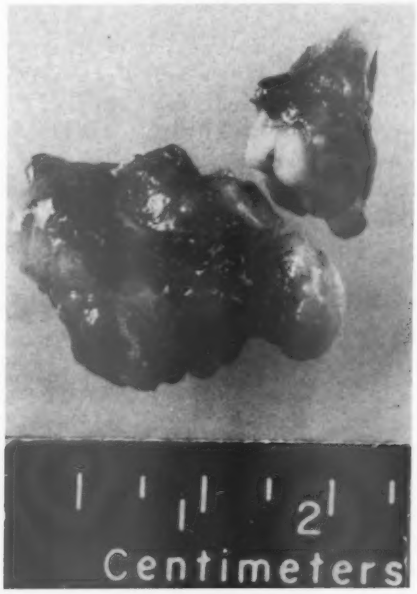

Fig. 2.—Tumor was approximately 3 cm. long and 2 cm. wide.

positioned, and the wound was closed with 000 silk sutures. The tumor was sent to the pathology laboratory for histopathologic examination. The patient left the operating room in good condition.

Pathology Report.—The mass of tissue measured 3.0 by 1.5 by 1.5 cm. This material was jellylike at the edge with some harder or fibrous areas at the center. Actually, on section, areas that resembled cartilage were encountered.

Microscopic examination of the tumor showed it to be composed of myxomatous tissue in which there was a large amount of connective tissue matrix and intercellular substance. The nuclei were widely separated and were small and uniform.

Dr. John C. Henthorne, pathologist, diagnosed the tumor as myxoma.

Postoperative Course.—The patient had an uneventful recovery and was discharged on Dec. 9, 1956. She was last seen on March 18, 1957. The ridge was completely healed, with a wide depression marking the site of the tumor. There was no visual or radiographic evidence of a recurrence.

FIBROMYXOMA AND ACCOMPANYING EPISODIC SYMPTOMS

An Illustrative Case Report

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OFTEN a patient who presents for consultation and treatment shows more than the usual concern about surgery that has been recently performed. This concern is prompted by exacerbation of the previous symptoms and aggravated by seemingly related disturbances.

The following case is reported because it illustrates the above and shows how good patient-surgeon rapport is essential in controlling the patient's latent cancerophobia.

CASE REPORT

The patient, a 44-year-old Negro married woman, had a chief complaint of radiating pain from the right mandible with episodic dizziness increasing in frequency. She had seen an oral surgeon in February 1957, for radiographic examination of her mandible. She was apprehensive about the healing of her right mandibular wound.

History.—In April, 1956, the patient noticed an enlarging intraoral bulge in the molar area of the right mandible with episodic pain and ache. The oral surgeon whom she first consulted biopsied the lesion, which the patient said he described as about the size of a quarter. In October, 1956, another biopsy was performed, and a course of penicillin therapy was given to control a superimposed infection which caused episodic swelling in the biopsied area. The oral pathologist reported all specimens as fibromyxoma. Along with her complaints of right-sided pain and earache, the patient for the past ten years has had difficulty in keeping her balance while walking if she does not keep her eyes upon a stationary object. Right ear deafness, with increasing bouts of dizziness, has caused her great concern in the last six months.

Examinations.—In August, 1957, the patient was hospitalized at St. Vincent Hospital. Her entire hospital stay was filled with outward anxiety. It was only after several attempts at examination, both physical and verbal, that the following facts evolved: Her family history was noncontributory. She submitted to hospitalization only at her daughter's insistence after several severe attacks of right radiating face and neck pain between February and August, 1957. A systems review was essentially normal in all respects, except for the already mentioned neuromuscular and neuropsychiatric ramifications.

Eyes: The lids were normal; the sclera were somewhat discolored. Visual acuity was decreasing with age. The rest was essentially normal.

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Ears: Externally normal. There was no preauricular tenderness.

Neck: There was no engorgement of veins or abnormal pulsations. The thyroid was not enlarged. The trachea was normal. No palpable lymph nodes were found.

Mouth and throat: The lips were symmetrical and acyanotic. There was no right lower lip paresthesia. Tonsils and pharynx, mucous membranes, and gingivae were normal. A scar in the buccal fold of the right body of the mandible with no apparent asymmetry was noted. The tongue was normal. The maxillary and mandibular molar areas were edentulous except for a mandibular first premolar, which was slightly mobile but nontender to movement.

Neurologic consultation: Symptoms of dizziness, especially while watching circular motions, were validated. Occasional nausea and dyspepsia were related to diet indiscretion. Slight loss of hearing in the right ear was evident. *Impression:* Suggestive of bilateral impaired or dead labyrinths. Radiographic and caloric test examinations were indicated.

Fig. 1.—Lateral view of right mandible showing posterior extent of bony lesion.

Clinical laboratory reports: Hemoglobin, hematocrit, and urine studies were normal, as were the blood cellular elements. Total urea nitrogen per 100 c.c. specimen was 15.0 mg.; fasting sugar was 156 mg. per 100 c.c.; alkaline phosphatase was 9.0 King-Armstrong units per 100 c.c.; calcium was 12.2 mg. per 100 c.c.; phosphorus (as phosphides and phosphates) was 3.0 mEq. per liter. An electrocardiogram was normal except for a sinus tacycardia rate of 110.

Radiology reports: Examinations of the skull, with special views of the petrous ridges bilaterally, revealed that there were no abnormal intracranial calcifications. The sella

turcica appeared normal. The internal auditory ridges appeared normal bilaterally. There was an area of radiolucency in the left petrous ridge superior to the auditory canal, which may have been due to pneumatization by mastoid cells. This was not present on the right side. Preoperative examination of the mandible revealed a large ovoid area of decreased density in the horizontal ramus of the right mandible, measuring approximately 3 cm. by 1.6 cm. The chest film was normal (Fig. 1).

Operation.—Following induction of adequate Pentothal sodium anesthesia supplemented with endotracheal nitrous oxide—oxygen, the head and neck were draped in an appropriate manner. By blunt and sharp dissection the buccal and lingual mucosa was reflected from about the body of the right mandible. From the mental area to the ascending ramus the alveolar bone was smooth except for a slight buccal bulge in the first molar area. Exploration disclosed a gelatinous, grayish lesion which exuded out of the buccal window. Adequate bone removal gave good visualization, and bleeding was minimal.

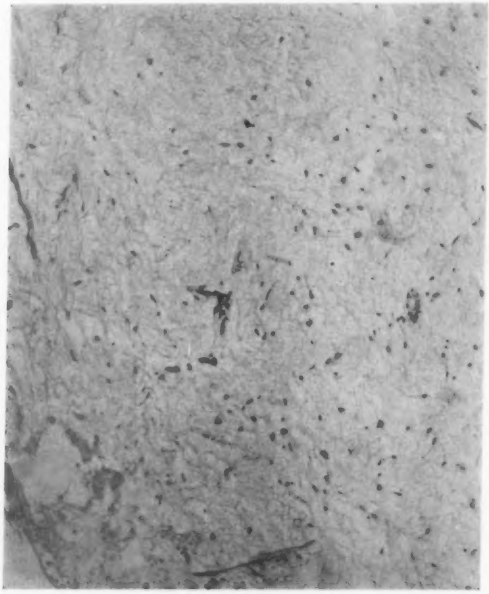

Fig. 2.—Medium-power photomicrograph showing embryonic character of cells and intercellular gelatinous substance.

The grayish, gelatinous mass was removed in several lobules. These were separate and discrete. Some bone trabeculation was noted within the interior of the cavity in the right mandible. After complete removal of the obvious mass, the floor of the cavity was inspected; bleeding there was minimal. The mandibular nerve and blood vessels were not visualized. Further curettage and débridement ensured healthy osseous tissue in all aspects of the cavity.

Thorough inspection was made anterior to the mental foramen. The mass extended about the root of the first premolar but did not involve the tissue about the cuspid. All rough areas of bone were made smooth. Gelfoam was placed in a loose manner within the cavity. The mucosa was approximated with 000 black silk sutures.

Pathology Report.—The specimen in formalin consisted of eight irregularly shaped pale tan to yellowish red pieces of soft tissue measuring up to 3.5 cm. in greatest dimension.

Sections cut against slight resistance showed a yellowish tan cut surface, and several of them contained a small amount of mucous fluid. Also present were two small pieces of bone and one tooth with caries and brown discoloration.

Microscopic sections showed a loose, lacy tissue of pale pink-staining quality in which scattered spindle cells and plump oval cells resembling fibroblasts were embedded. Near the margin a bundle of tissue resembling nerve was seen incorporating slitlike channels filled with blood. A few round plasma cells were infiltrating the tissue. A capsule could not be identified (Fig. 2).

Diagnosis: Fibromyxoma (odontogenic in character). No evidence of anaplasia or other malignant properties.

COMMENT

The myxoma is usually a central tumor, but it may perforate bone and then may form a visible tumefaction in the mouth. As a rule, one may use the occurrence away from the tooth-bearing part of the jaw and the malignant behavior as signs that the tumor is of the osteogenic type. The myxoma forms from retained islands of embryonic tissue. It is a lesion in which the intercellular substance produced in excess is a semifluid or gelatinous substance. Secondary myxomas are recognized and represent a degenerative process of a fibroma, fibro-osteoma, or chondroma. The soft tumor mass expands the bone and often causes complete destruction of the cortex.[1-4]

Our patient expressed the opinion that she felt that the tumor mass was growing because the first operations were done as office procedures. She was convinced that the right earache was due to the necessity of having the mouth open for prolonged periods of time during the biopsies under local anesthesia.

This lesion involved both tooth-bearing and edentulous areas. At operation the right mandibular first premolar root was found to extend well into the tumor mass, and it was deemed best to treat this growth as an odontogenic tumor although it seemingly was a recurrence of the original lesion.

The reason for the wide local excision rather than segmental resection was explained to the patient, and her previous accompanying symptoms were thoroughly discussed with her. An earlier discussion of the character of this lesion and the labyrinth syndrome would have helped to overcome the patient's anxiety.

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PLASTIC CLOSURE OF ORONASAL FISTULA

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ORONASAL clefts or fistulas may result from congenital malformation, trauma, infectious disease, an inflammatory process, or improper postoperative care of tissues at the site of the fistula formation.

Most of the difficulty encountered in closure of an oronasal fistula arises from failure to apply certain basic surgical principles in the management of such cases.

A case of oronasal fistula, in which a plastic closure was accomplished by the relaxing incision technique, is reported.

CASE REPORT

Chief Complaint.—Patient A. B., a 39-year-old Negro man, was referred to the oral surgery section of the Research and Educational Hospitals on April 24, 1956. His chief complaint was of a large perforating defect of the hard palate.

History of Present Illness.—On July 20, 1955, a tumor of the hard palate had been removed at another hospital. Following that operation, a large oronasal communication developed. Surgical correction was not considered advisable at the time. The pathologist at the other hospital had diagnosed the tumor as a benign "adenoma" of the hard palate. The patient had noted a change in his speech (nasal speech), and he also complained of food passing into his nose. He had used foam rubber to prevent food passage.

Clinical Examination.—Clinical examination revealed a large perforating defect in the midline of the hard palate (Fig. 1). The defect measured 1.5 by 1 cm. in diameter. Bimanual palpation disclosed no evidence of pain or exudation of purulent discharge. A carious lesion was present in the left upper first premolar. The gingivae, tongue, and other soft tissues appeared to be normal. Oral hygiene was fairly good except for nicotine discoloration of the teeth. A nasal examination indicated that the mucosa of the septum, inferior turbinate, and meatus was normal.

A complete physical examination failed to reveal any abnormalities other than the oronasal defect and evidence of an abdominal hernia which had been repaired in 1943.

Clinical diagnosis: Postsurgical defect, cleft or fistula of the hard palate.

Laboratory Data.—Urinalysis was normal. The white blood cell count was 9,500 with a normal differential, and the red blood cell count was 5,000,000. Hemoglobin was 13.2 grams per 100 c.c. Kahn and Wassermann tests were negative.

Roentgenographic Findings.—An occlusal roentgenogram revealed a large, well-circumscribed defect located in the midline of the hard palate. This was approximately 2 by 1.5 cm.

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in diameter. Periapical dental films showed a roentgenolucent lesion at the apex of the first premolar region and a carious lesion on the distal surface of the crown, involving the pulp chamber (Fig. 2).

Preoperative Course.—On May 18, 1956, under local anesthesia, the left upper first premolar was extracted. The wound healed by first intention. The patient was scheduled for repair of the palatal defect under local anesthesia on July 3, 1956, on an outpatient basis.

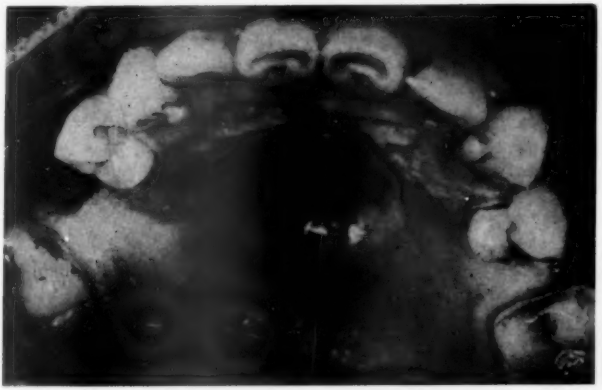

Fig. 1.—Preoperative clinical view showing a large perforating defect of the hard palate in the midline.

Fig. 2.—Occlusal roentgenogram showing a bony defect located in the midline of the hard palate.

Operation.—The patient, in the supine position, was draped and prepared in the usual manner. Local anesthesia was induced by blocking the left and right posterior greater palatine nerves with 1.5 per cent Primacaine. The nasal cavity was anesthetized with a

topical anesthetic agent. With a No. 15 Parker blade, an incision was made through the mucoperiosteum to the bone on both palatal sides. The incision extended across the long axis of the teeth, opposite the premolars, approximately 0.5 cm. away from the teeth. The mucoperiosteal flap was then raised from the hard palate with periosteal elevators. When sufficient tissue had been relaxed, the flaps were held with a fine tenaculum to approximate the margins after the edges of the fistula were freshened. The edges were approximated with 6-0 nylon sutures. An atraumatic needle was used to place the mattress sutures throughout the length of the hard palate. Simple interrupted sutures were then placed along the entire palatal surface; they were made tight enough that no leakage of air or fluid through the suture line was possible. This gave a broad contact of raw tissue without tension. The side incisions were packed with pieces of iodoform gauze impregnated with tincture of benzoin.

Postoperative Care.—The postoperative orders consisted of the following: (1) elevation of the headrest, (2) sedation with Empirin compound No. 3 every four hours for pain only, (3) oral rinses with warm saline, and (4) liquid diet for the first forty-eight hours, to be changed to a soft diet as tolerated. Vigorous rinses, sneezing, and coughing were not permitted.

Fig. 3.—Photograph showing complete closure of the oronasal fistula with excellent reconstructive results (May 10, 1957).

Postoperative Course.—The immediate postoperative course was uneventful except for palatal edema. On July 6, 1956, the iodoform packs were removed. The wound appeared to be healing with granulation tissues.

The patient returned to the clinic on July 17, 1956. The sutures were removed, the incision having healed by first intention.

Follow-up.—The patient was seen again on Aug. 25, 1956, and examination revealed complete closure of the oronasal fistula with marked improvement in his speech.

His final examination was on May 10, 1957. At that time, reconstructive results were seen to be excellent, and he was dismissed from the clinic (Fig. 3).

COMMENT

Whenever entrance into the nasal cavity as the result of an injudicious or necessary surgical procedure or an accident occurs, immediate closure is

obviously the indicated treatment. In some instances, loss of tissue is so extensive that surgical repair is not feasible. If, however, sufficient soft tissue remains, local transposition may afford the patient a far more comfortable condition than can be furnished by means of prostheses.

SUMMARY

The palatal defect in this case was caused by surgical excision of a benign tumor of the hard palate. The fistula was closed surgically in one stage. The successful result is attributed to adherence to the rules of cleft palate surgery and to careful preoperative planning as well as postoperative care of the wound.

USE OF SCLEROSING SOLUTION IN TREATMENT OF AMELOBLASTOMA

Preliminary Report

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THE ameloblastoma is a benign, radio-resistant neoplasm of odontogenic origin. The clinical and roentgenographic features and the histopathology of the tumor are well known.[13] Management remains a moot question, however, primarily because the tumor has a persistent tendency to recur locally. Metastasis through systemic spread has never been reported in the literature, and when metastasis is present in the lung it may be explained by inhalation of fragments of the tumor into the bronchial tree (in other words, implantation of tumor cells in the tissues).

Total enucleation of the tumor can result in complete cure. However, the architectural pattern of the tumor is such that complete removal is seldom, if ever, achieved by enucleation. Block or radical resection, therefore, has become the most widely used form of therapy. Even after radical resection, however, there is recurrence in 13 per cent of the cases,[11] and recurrence may occur as much as twenty-five years after the original surgery.[12]

This article illustrates the problems encountered in the clinical management of recurrent ameloblastoma and reports preliminary findings on a new treatment of the neoplasm.

CASE REPORT

J. H., a 50-year-old white man, had been in excellent health except for many episodes of recurrent tumors in the right mandible and facial bones. His dental history dated back over a twenty-two-year period, and during that interval he had undergone "multiple" surgical procedures.[10]

In 1937 the right mandibular third molar was extracted because of dental pain. No preoperative dental roentgenograms were taken. Healing was prolonged. A slow-growing

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swelling developed in the same area, and in 1947 a "bone cyst" was removed under local anesthesia. This was a "local" excision of the lesion intraorally. The tumor was diagnosed as "adamantinoma of the mandible."

In 1948, six months later, the patient presented a solitary, solid tumor mass involving the right ascending ramus and body of the mandible, anterior to the right first molar area. The patient was admitted to the hospital for a "radical" or "block" resection, and a right hemimandibulectomy was performed.

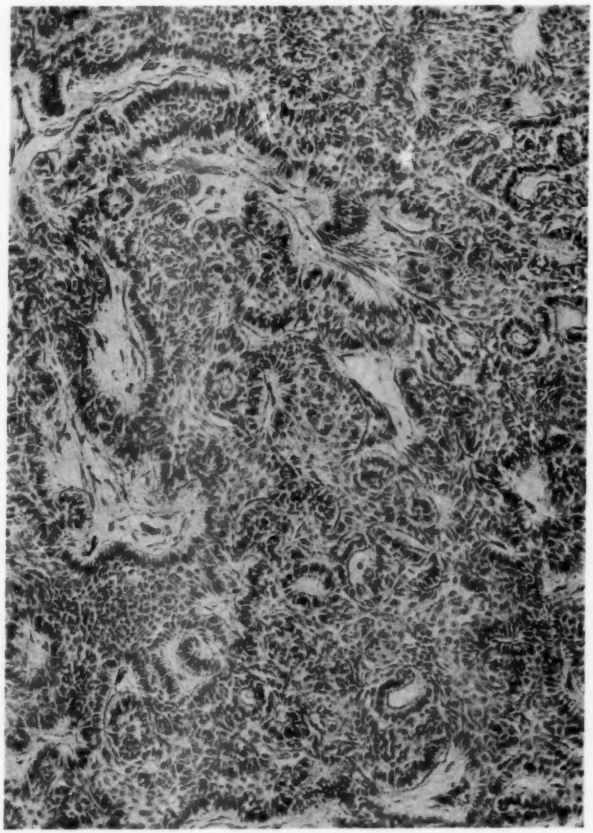

Fig. 1.—Photomicrograph showing typical appearance of ameloblastoma.

The patient was seen periodically and was quite well until August, 1954, when he returned with a mass in the right temporal region. The radiographic examination was essentially normal, and the mass was removed in toto under local anesthesia. The growth was encapsulated and embedded in the temporal muscle. The pathologic diagnosis was ameloblastoma involving the temporal region.

The patient was seen again in August, 1956, when he presented a protrusion of the right malar region. Examination showed that the mass was hard, firm, nontender, and sessile. The skin was stretched, shiny, and intact. There was affection of buccal branches of the seventh nerve, as indicated by drooping of the right upper lip and cheek. The eye was not

displaced, and there were no subjective ocular symptoms. Roentgenographic findings disclosed that the tumor was progressing and destroying portions of the right zygoma (including the orbital process and lateral aspect of the orbital rim) as well as the lateral bony wall of the right antrum.

Surgical exploration revealed a tumor that had invaded deeply into the tissue spaces and had caused extensive destruction of the right zygoma, the lateral wall of the orbit, and the maxilla. Since the patient had not consented to radical resection, the tumor mass was only partially removed. The postoperative course was uneventful.

The microscopic section revealed cords and nests of simple columnar epithelium lining cystlike spaces. These showed variations in size. Some were empty; others were filled with an amorphous, fibrillar, eosinophilic substance. The columnar cells were supported by a loose tissue whose cellular components resembled the stellate reticulum of the enamel organ (Fig. 1). The growth was diagnosed as ameloblastoma, incompletely removed.

Fig. 2. Fig. 3.

Figs. 2 and 3.—Lateral and front views of the patient, showing recurrent ameloblastoma involving the maxillofacial structures during the past twenty-two years. He has had "multiple" surgical procedures (December, 1958).

The patient now presented an inoperable condition and in December, 1958, he returned with progressive swelling in the right zygomatic facial region (Figs. 2 and 3). The subjective symptoms were occasional episodes of "dull ache" with throbbing and pressure. He had deafness in the right ear and distortion of the right eyeball and vision.

Two major problems confronted us: (1) the mode of therapy and, (2) the repeated episodes of recurrence of the tumor.

Recently, Dalitsch,[4] at the University of Illinois, has reported and reintroduced the concept of induced regression of neoplasms by the controlled

limitation of vascular supply. His views are authenticated by many well-known workers, including Everson and Cole,[5] Lewis and Aptekman,[6] and Birch.[1]

Cole[2, 3] and his associates have clearly pointed out the mechanisms by which the neoplasm may spread and have categorized them in four major groups: (1) by lymphatics, (2) by vascular channels, (3) by contiguity through tissue planes, and (4) by implantation. The mechanisms by which the ameloblastoma spreads include the latter two groups.

The authors believed that they could use sclerosing solutions to produce ischemia in the entire area, including the tumor. We also felt that, by injecting sclerosing agents, we could produce fibrogenesis around the tumor and thereby control the mechanism of spread of the neoplasm.

In 1936, Rice[7] reported that he had treated over 600 hernias with the sclerosing agent, sodium psylliate, which gave him encouraging results without producing ill effects. He concluded that this solution furnished the best method of developing fibrogenesis in the treatment of hernia.

In view of Rice's results, Schultz and Shriner[8] decided to test various sclerosing agents on a variety of animals. In brief, the animal experiments showed the following:

1. Sodium psylliate is the best of the fibrosing agents investigated.
2. It is noninjurious to tissues generally.
3. Injection into heart produces no recognizable effects.
4. No infection follows the treatment.
5. Sodium psylliate produces no apparent systemic disturbances, even when injected intravenously into animals.
6. Fibrosis of the tissue starts in four to six days.

The harmlessness of treatment with sodium psylliate and the quick results obtained convinced Schultz[8] that it was the agent of choice for treating subluxation of the temporomandibular joint. Thus, Schultz[9] was the first to advance the idea twenty-two years ago; since then, he has been injecting Intracaine (Squibb) or Sylnasol (Searle) into the joints of patients with disorders involving hypermobility of the temporomandibular joint.

In his experience, Schultz has never encountered any untoward post-injection sequelae. He believes that the above sclerosing agents are quite safe.

Sclerosing agents also have been injected into hemangiomas to produce fibroblastic proliferation and sclerosis. The clinical results have been favorable.

With the foregoing experimental and clinical evidence in mind, we decided to give the sclerosing agents a clinical trial in the present case and inject them into the inoperable recurrent ameloblastoma. The patient was told the nature of the treatment, and we obtained his consent to institute therapy.

Nature of Therapy.—First, using a hypodermic syringe with a 20 gauge needle, 5 c.c. of Sylnasol was injected around the tumor mass to determine tissue reaction and the patient's response. The patient tolerated the injection, and the skin and surrounding tissue showed no untoward reactions. Then the larger dose of 15 c.c. of Sylnasol was injected deep into the tumor mass and surrounding tissues. The injection technique consisted of infiltrating the entire area, with the idea of limiting the blood supply by causing fibrogenesis.

The injections were repeated every two weeks. After eight weeks a biopsy was performed to permit study of the tissue reaction and changes in the tumor mass. The pathologic findings were fascinating.

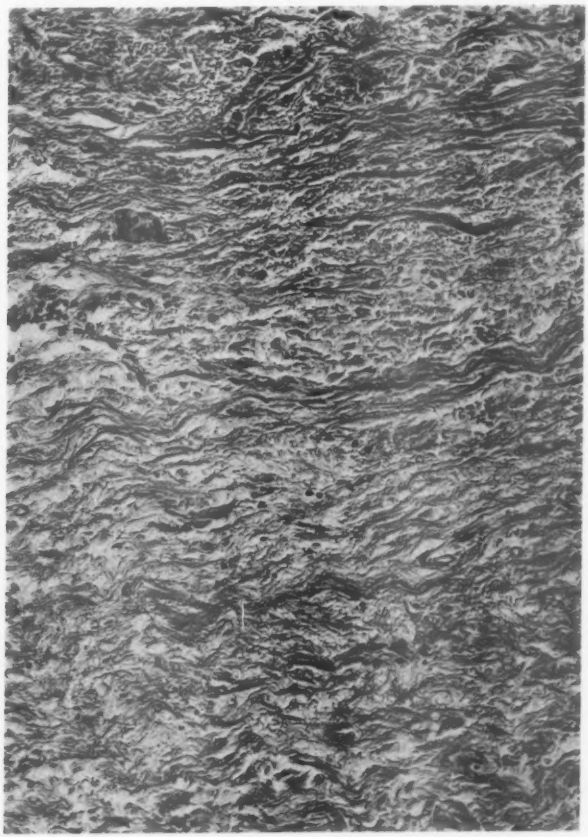

Fig. 4.—The sclerosing agent (Sylnasol) was injected into the tumor mass. After eight weeks a biopsy was performed. The microscopic findings show dense fibrous connective tissue with some fragmentation of collagen fibers and chronic inflammation. No evidence of ameloblastic cells was noted in the biopsy material.

Microscopic description: The sections showed a triangular tissue mass one surface of which was covered by a stratified epithelium. The covering epithelium was about 8 cells thick, with short, blunt rete pegs. While the surface cells of the epithelium were filled with basophilic granules, the basal cells were encroached upon by golden brown pigment. The immediate underlying connective tissue of the epithelium was loose and composed of fibroblasts and lymphocytes scattered in a matrix containing bizarre, fragmented, collagenous fibers. The bulk of the remaining tissue was composed of dense collagenous fibers, arranged in a fibrillated and longitudinal fashion. Perivascular infiltration by lymphocytes was observed in some areas. Thin layers of adipose tissue were also seen. There was no evidence of ameloblastoma (Fig. 4).

Diagnosis: Dense fibrous connective tissue with some fragmentation of collagen fibers; chronic inflammation. No evidence of ameloblastic cells was noted in the biopsy material.

The biopsy report encouraged and stimulated our efforts and trials. The injections were repeated at the two-week interval. Twelve weeks later we found that chemical liquefaction of the tumor mass and multiple aspiration of tumor exudate revealed cellular debris. Several weeks later multiple fistulas were noted, and marked regression in size was evident. At the end of six months large representative biopsy specimens were again taken from several areas of the tumor. The pathologic findings were consistent with dense fibrous connective tissue. No ameloblastic cells were noted.

The patient was seen repeatedly. The multiple sinuses closed spontaneously after several weeks (April, 1959), and the patient remarked that he was feeling better than he had for many months.

Fig. 5. Fig. 6.

Figs. 5 and 6.—Clinical appearance in April, 1959, shows marked regression of the tumor mass. The patient had received eight injection treatments, in doses of 10 to 15 c.c., over a twelve-month period.

The injections were discontinued, and the patient has shown marked regression of the tumor mass (Figs. 5 and 6). In all, the patient had received eight injection treatments, in doses of 10 to 15 c.c., over a twelve-month period.

CLINICAL OBSERVATION AND SUGGESTIONS

Following injection of the sclerosing agent, Sylnasol, into an ameloblastoma, there is complete fibrosis around the tumor mass, no evidence of ameloblastoma

of the tissue is noted in the tumor, the tumor undergoes a marked regression in the size, and there is no evidence of spread of the neoplasm.

We suggest that Sylnasol may be injected every other week. The recommended dose is 10 to 15 c.c., and six to ten injections are needed to treat a neoplasm, depending on the size of the tumor.

At the present time we are able to institute the therapy just described only for those tumors which are accessible to local injections.

COMMENT

Our clinical observation reveals that the use of sclerosing agents in the treatment of ameloblastoma shows promise for the future. By injecting sclerosing agents into the neoplasm, we may find (1) proliferation of fibrous cells, (2) disappearance of neoplastic cells, (3) regression of neoplasm, and (4) possible blocking of the local or systemic spread of neoplastic cells. Thus, the use of sclerosing agents also opens up many avenues in the treatment of benign and malignant neoplasms. This may facilitate surgical procedures and prevent systemic metastasis.

Therefore, we suggest that this interesting effect should be studied on a larger series of patients over an extended period of time. Thus far only a few patients have been treated by this method, and there has not been a sufficient time lapse to permit us to draw positive conclusions. This is a preliminary report, and our clinical claim is supported by three cases of ameloblastoma. Further research in the clinical application is under way.

It is our earnest belief that these agents should be given an experimental and clinical trial in the hope that someday we might control one of the killers of the human race—cancer.

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PERIODONTICS

STUDIES ON THE ETIOLOGY OF PERIODONTOSIS

II. Glomera as Vascular Components in the Periodontal Membrane

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INTRODUCTION

THE presence of short-circuiting channels known as glomera was first demonstrated histologically by Hoyer[1] in the terminal phalanges, ears, nose, and tip of the tail in the rabbit, the guinea pig, the cat, and the dog. Prior to this original histologic report, several other anatomists, namely Sucquet,[2] Müller,[3] and Hoyer,[4] had reported their existence during gross studies. Masson[5] gave a tabulated historical account of studies made on these unusual circulatory shunts; in the same paper he reported their presence in normal and pathologic tissue and referred to them as the glands of Luschka. He emphasized that glomera were consistently found as tumors associated with the glands of Luschka.

Several standard descriptions of normal human periodontium have been reviewed, and in none was there any mention of the presence of glomera associated with healthy tissue. During the course of this study dealing with pathologic changes in the periodontal membrane associated with periodontosis and periodontitis, we have encountered glomera in every case. In an earlier paper,[6] we made mention of their existence, but no detailed description and postulation as to their role were included. This article deals specifically with the histology of these glomera in the human periodontium associated with periodontosis and periodontitis.

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***Assistant Professor of Histology and Embryology.

The glomus is in the form of a convoluted vessel which serves as a shunt between an arteriole and a venule. Circulation in the extremity of the arterial system bypasses or partially bypasses the capillary bed and is shunted into the venous system via such a channel. There may be more than one glomus associated with a single arteriole and venule. The glomera found in the periodontal membranes studied are histologically different from the arteriovenous anastomoses reported by Provenza[7] in the human dental pulp and in the human and dog myocardia as reported by Provenza and Scherlis[8, 9] (Fig. 1). Masson[5] presented a possible explanation of their function, stating that the dilatations and constrictions of the glomera control the circulatory rate through the digital regions. We are presenting herein another hypothesis as a possible application of their role in the periodontium.

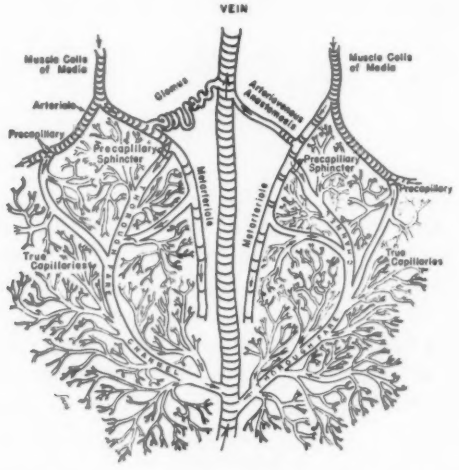

Fig. 1.—Schematic drawing of microcirculation in dental pulp and periodontium of man, showing path of blood from arteriole into metarteriole being shunted to vein via arteriovenous anastomosis. Note that the arteriovenous anastomosis takes a straight path from the parent vessel to the vein. On the other side of the diagram, observe the glomus connecting an arteriole to a venule also bypassing the capillary bed. It will be noted that the glomus takes a tortuous path from the parent vessel to the venule.

MATERIALS AND METHODS

In this study of glomera associated with human periodontium, the tissues were obtained from two patients, one diagnosed as suffering from third-stage periodontosis and the second as suffering from periodontitis complex according to the definition of these terms as revised by us.[6]

The teeth and surrounding tissues from the patient suffering from third-stage periodontosis were extracted under Novocaine-Pontocaine-Cobefrin block. In the patient with periodontitis complex the lower left cuspid was anesthetized with 2 per cent procaine hydrochloride with a mandibular block. The teeth and their adnexa were removed. The tissues from both patients

were fixed by the gradual formalin fixation method[6] and sectioned in both longitudinal and cross sections, 6 microns in thickness, by the modified parlodion method as described by Provenza and Cheng.[10]

The sections were serially arranged, and four types of stain were used on representative areas: hematoxylin and eosin, Mallory's triple connective tissue stain, Unna's stain (as described by Gatenby and Painter[11]) for muscle and connective tissue fibers, and Mann's methyl blue-eosin stain (as described by Gatenby and Painter[11]). The last two stains were employed to make possible the differentiation of the muscle fibers and connective tissue fibers of the vessels.

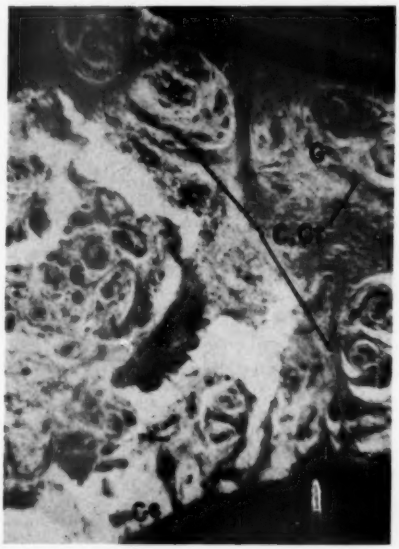

Fig. 2.—Periodontium in the bifurcation. Note capsule of dense collagenous connective tissue (*C.Ct.*) enveloping glomus (*G*) in the periodontium superior to the intraradicular alveolar septum. The section is bordered by the cementum (*Ce*) of the two roots. (Hematoxylin and eosin stain. Magnification, ×430; reduced ⅙.)

OBSERVATIONS

Glomera were observed in the periodontium surrounding the cementum. Although they are qualitatively the same relative to their location in this tissue, quantitatively they are different. It has been observed that as one travels apically the frequency with which glomera are encountered increases. The greatest number of these structures is found in the intraradicular periodontium superior to the alveolar septum (bifurcation). In this area as many as fourteen such structures have been observed (Fig. 2).

In the periodontium, the single glomus appears as a wavy tubular connection between an arteriole and a venule. Toward the venous terminal, the convoluted vessel is distinctly venous in histologic characteristics (Fig. 3). The

wall is comparatively thin and flattened. The lumen is large and narrow in outline. The endothelial lining appears to be continuous with that of the parent vessel (arteriole or metarteriole) and the communicating venule. However, some of these endothelial cells, particularly on the arterial side, are conspicuously different from those occurring in other blood vessels in that they are extremely large and project into the lumen (Figs. 4 and 6). The shape of these cells, as refected by the nucleus, varies from oval to round, depending upon the degree of contraction of the muscle cells which envelop them. The

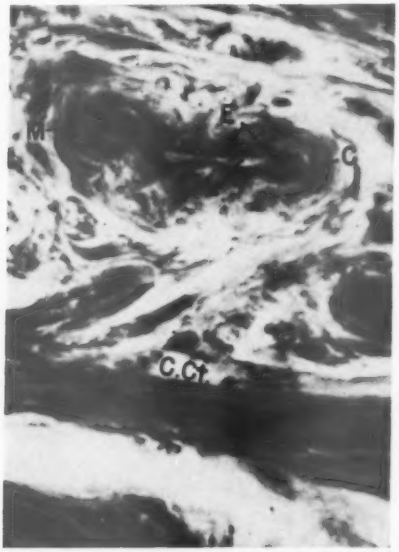

Fig. 3.—Venous aspect of glomus. Note the flattened appearance and decreased thickness of the vessel wall. The elongated endothelial nuclei (*E*) circumferentiating the lumen (*L*) are surrounded by muscle fibers (*M*) and collagenous fibers (*C*). The capsule of dense collagenous connective tissue (*C.Ct.*) is seen in the lower portion of the photomicrograph. (Hematoxylin and eosin stain. Magnification, ×980; reduced 1/5.)

contracting force of the myofibers of the media may be so intense that it causes the endothelial cells to shorten, resulting in the nuclei becoming round and projecting into the lumen of the vessel. It is not uncommon to find the lumina of glomera occluded in this manner (Fig. 4). Surrounding the endothelium of the tunica intima is found a well-developed tunica media and a fibrous tunica adventitia. Toward the arterial terminal the glomus is arterial in histologic make-up, with the characteristically rounded shape (Fig. 5). The walls are comparatively thicker, consisting of a tunica intima, muscular media, and a fibrous adventitia. The myofibers which circumferentiate the intima of the glomus at either the arterial or the venous ends are similar to those which constitute the media of other vessels, except that the muscle fibers of the glomus are shorter and broader. It is also worthy of note that cells resembling myoblasts were frequently encountered in the media. These cells are

somewhat irregular in shape. Their nuclei consist of diffuse chromatin granules staining hypochromatically. A small but definite nucleolus is always present (Fig. 5).

Still another cell is invariably encountered. Although this cell may be found in any area in the media, it is most frequently seen in the vicinity of the intima (Figs. 4 and 5). The cytoplasm of this cell is conspicuously wanting in cytoplasmic constituents. The nucleus is ovoid and contains fine chromatin particles with a distinct nucleolus. This cell resembles the mesenchymal cells found in the adventitia of the vessels and the interstitial tissues of the periodontium.

Fig. 4.

Fig. 5.

Fig. 4.—Complete glomus demonstrating arterial (*A*) and venous (*V*) terminals of this vessel. The capsule (*C.Ct.*) surrounding this structure is artifactitious. In the arterial aspect, note endothelial cells (*E*), which are greatly enlarged and projecting into the lumen (*L*), muscle fibers (*M*), and collagenous fibers (*C*) making up the media. The mesenchymal-like cells (*Me*) are observed in the media of the arteriole contiguous to the endothelium. (Hematoxylin and eosin stain. Magnification, ×980; reduced ⅕.)

Fig. 5.—Arterial aspect of glomus. Muscle fibers (*M*) and collagenous fibers (*C*) are responsible for increased thickness of media of arterial wall. Mesenchymal-like cells (*Me*) are interspersed in media. (Hematoxylin and eosin stain. Magnification ×980; reduced ⅕.)

Surrounding each glomus is a loosely arranged coat of collagenic and elastic fibers as indicated by Unna's stain. These are arranged in bundles and are oriented circumferentially around the convoluted vessel. In cross section, the glomera appear as several individual units, each with its own fibrous coat. Within this coat, the convoluted vessel appears as circular units of varying sizes, and each section can be readily identified as being a section of the arterial or venous terminal by its histologic characteristics (Fig. 6). In regions where the individual glomera are closely associated, the fibrous capsule

of the two adjacent units fuse as one; however, these separate from each other in the less compact areas. Associated with the enveloping fibrous coat and the tunica adventitia of the vessels are fibroblasts and mesenchymal cells. No section of any glomus was observed to possess the characteristics of capillaries.

Fig. 6.—Two glomera in close proximity to one another. It will be noted that the intervening connective tissue capsule (*C.Ct.*) is common to both structures. The space is artifactitious. Note venous aspect (*V*) and arterial (*A*) aspect with swollen endothelial cells (*E*) occluding the lumen. (Hematoxylin and eosin stain. Magnification ×450; reduced $\frac{1}{5}$.)

DISCUSSION

The glomera, as seen in the periodontal membranes studied, are recognizably different from the arteriovenous anastomoses found in the human dental pulp. In the periodontium, the glomera take a much convoluted course between the parent arteriole and the venule with which it communicates. In the dental pulp the arteriovenous anastomoses are often encountered as straight shunts between the arteriole and venule or metarteriole and venule. Anatomic differences are even more striking. Whereas in the glomera the endothelial cells of the intima are so large that they may project into the lumen of the vessel, in the arteriovenous anastomoses of the dental pulp and the ventricular myocardium, these cells are no different than in other vascular elements. Further in the glomera, the muscle cells of the media are short and broad and may be several layers in thickness. In the arteriovenous anastomoses of the dental pulp, the myofibers are of the characteristic size and shape and rarely exceed one or two layers in thickness. In cases in which the shunt connects a metarteriole with a venule, the thickness of the media is not only reduced to one cell layer but is discontinuous on the metarteriole terminal. Although

Masson[5] describes the tunica media of the glomera in the skin as epithelioid in nature, no such description can be given to the cells of the media of the glomera in the periodontium. The cells of the media of the glomera take on a characteristic red color with Unna's stain, which is indicative of their muscular nature.

While the adventitia of glomera in the periodontium is consistently of a compact type closely associated with the media, in the ventricular myocardium of both man and dog, it is loose and often indistinct.[8, 9] In the human dental pulp, an adventitia per se is nonexistent.[7]

We reported that there was a decrease in the number of capillaries in the periodontal membrane associated with third-stage periodontosis.[6] It is postulated here that the appearance of glomera, as arteriovenous shunts, serves as a form of compensation on the part of the tissue to regulate normal flow of blood. The decrease in the number of capillaries is attributed to partial or total strangulation of these minute vessels by the disarranged connective tissue fibers. In the case of glomera, it is postulated that their heavier walls and large diameters render them less susceptible to strangulation. Histologically, this hypothesis is borne out by the severe disarrangement of the fibers in the area abutting the roots where as many as fourteen glomera were observed. It is doubtful whether the glomera contribute to the onset of periodontosis or periodontitis; rather, their presence may be considered an attempt at a compensatory reaction on the part of the affected tissue. The formation of connective tissue fiber capsules around the glomera could contribute to the further disarrangement of the fibrous elements in the periodontium.

The histologic composition of the glomus, as given under observations, strongly indicates that this vessel originated as two buds—one from the arteriole and the other from the venule. The elongation of the two buds and the eventual fusion of the blind ends result in a structure characteristically arterial on the one end and venous on the other. This concept is supported by the anatomic structure of the glomus. Of even greater significance is the fact that mesenchymal cells and myoblast-like cells have been observed as an integral part of the media of the glomera. Certainly, the presence of the totipotent mesenchymal cell and a myoblast-like cell strongly suggests that the periodontium is attempting to undergo reparative changes.

In conclusion, it is believed that the efficacy of increased vascularization of this type is indeed doubtful. It is obvious that continuous shunting of blood from the arterial to the venous systems results in partial or total curtailment of blood flow through the capillary bed, thereby decreasing the metabolic interchanges which would normally occur through the capillary walls. The prolongation of this condition may well further aggravate and continue the degenerating process within the periodontium.

The authors wish to acknowledge the valuable assistance received from Dr. Myron S. Aisenberg, Dean and Professor of Pathology, the surgical procedures by Joseph Patrick Cappuccio, Associate Professor of Oral Surgery, and technical assistance in photomicrography from Mr. Claude P. Taylor, Director of the Department of Visual Aids, Baltimore College of Dental Surgery, Dental School, University of Maryland.

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ORAL MEDICINE

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RECURRENT HERPETIC GINGIVOSTOMATITIS TREATED WITH GAMMA GLOBULIN

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ENCOURAGING results from administration of pooled gamma globulin to patients with herpetiform oral lesions were reported by Strean and associates.[1] Other viral diseases, such as herpes zoster and chickenpox, have also been treated successfully by intramuscular injections of gamma globulin.[2]

A relatively high antibody titer against the herpes simplex virus is found in the blood of most adults.[3] It can be assumed, therefore, that such antibodies also will be present in pooled gamma globulin.

METHOD AND MATERIAL

Ten patients with recalcitrant recurrent herpetic gingivostomatitis were treated with intramuscular injections of gamma globulin.* All of these patients gave a history of recurrent painful oral lesions over periods of many years. They all had received a number of unsuccessful treatments, and in each case active lesions were present at the time of administration of the gamma globulin.

A detailed history was recorded for each patient. Possible correlation was sought between allergies or menstrual abnormalities and the oral lesions. Various dosages of gamma globulin were administered intramuscularly in the gluteal muscles. Only negligible local discomfort followed the injections.

CASE REPORTS

CASE 1.—A 21-year-old male dental student gave a history of recurrent oral lesions over a period of several years. The individual lesions did not last more than six to eight days, but new lesions readily developed, so that the patient was seldom free of them for more than two weeks at a time. The lesions had been present in continuous succession during the three months prior to admission of the patient.

From the University of Michigan School of Dentistry.

*This study was initiated on the advice of Dr. L. P. Strean, Department of Dental Medicine, Merck, Sharpe & Dohme, West Point, Pennsylvania, and the gamma globulin was supplied through the courtesy of this company.

Diagnosis: Recurrent herpetic gingivostomatitis.

Treatment: Gamma globulin, 10 c.c., was administered intramuscularly.

Result: The herpetic lesions that were present at the time of administration of the gamma globulin healed in a few days. The patient was completely free of lesions for a period of three months; then he developed two small lesions that were practically painless and healed rapidly. Since that time, the patient has with intervals of two to three months experienced one or two small lesions. These lesions have all been smaller and less painful than those he had before the gamma globulin therapy. During the one and one-half years of observation since he received the gamma globulin, his herpetic lesions have never approached the previous severity.

CASE 2.—A 22-year-old male dental student had a history of recurrent painful oral lesions for the last seven to eight years. The individual lesions healed in four to seven days. Usually, new lesions developed within a few days, but occasionally he had been free of them for as long as two months.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: Two injections of 5 c.c. of gamma globulin were administered five days apart.

Result: Three rather large lesions that were present at the time of the initial injection healed within three to four days. Three or four new lesions developed the day after the initial injection. These lesions were small and only slightly painful, and they healed in two to three days. Since that time, no further lesions have appeared during six months of observation.

CASE 3.—A 22-year-old dental student had been bothered with painful oral lesions since childhood. It would take about a week for the individual lesions to heal; sometimes the healing took a little longer, depending upon the size. The patient usually developed crops of two to three lesions, and new lesions appeared before the old ones healed. On rare occasions, he had been without any lesions for as long as one week.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: Gamma globulin, 10 c.c., was administered in one injection.

Result: Two lesions that were present at the time of the injection healed in five to six days. The patient was completely free of lesions for two months. A few small lesions appeared later, but those were smaller and less painful and they healed in a much shorter period of time than the lesions he had experienced prior to treatment. The patient has been under observation for six months following the gamma globulin therapy.

CASE 4.—A 31-year-old dental student had suffered from recurrent painful oral lesions for as long as he could remember. The individual lesions would heal in four to seven days.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: Two injections of 5 c.c. of gamma globulin were administered five days apart.

Result: The patient's oral discomfort gradually subsided during the two to three weeks following the injections. Then, for a period of three to four weeks, he was free of lesions. Later he developed a few small lesions, but these were not painful enough to bother him. He stated that for six months following treatment his oral condition had improved greatly.

CASE 5.—A 34-year-old man had a history of recurrent painful oral lesions over a period of approximately fifteen years. The individual lesions healed in seven to ten days, but new lesions usually appeared before the old ones healed.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: One injection of 10 c.c. gamma globulin.

Result: The lesions that were present at the time of the injection healed in a few days. The patient was completely free of lesions for six to seven weeks. Since that time small

lesions have appeared occasionally, but they have been distinctly less severe than those that developed prior to the treatment. This patient has been observed for five months following the administration of gamma globulin.

CASE 6.—A 40-year-old woman had a history of recurrent painful oral lesions since childhood. The lesions usually appeared three to four days prior to the onset of her menstrual period, but she also developed them at other times.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: Two injections of 5 c.c. gamma globulin were administered, with seven days between each injection.

Result: Over a period of seven months following the injection, the patient had developed only two small herpetic lesions, one of them following a large intake of citrus fruit.

CASE 7.—A 26-year-old woman presented a history of recurrent oral lesions since childhood. The lesions occurred at intervals of two to three weeks, and the individual lesions usually healed in about one week.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: Two injections of 5 c.c. gamma globulin were administered with a four-day interval between injections.

Result: The lesions that were present at the time of the initial therapy healed in four to five days. No new lesions developed until the patient had an impacted wisdom tooth extracted two months later. Two more injections of gamma globulin, 5 c.c. each, were then administered. The patient has developed only two small lesions over a period of twelve months since that time.

CASE 8.—A 19-year-old female patient gave a history of recurrent oral lesions since early childhood. Until a year prior to admission to our clinic, the lesions developed only a few times a year, but during the last year she has practically never been free of them. It took five to ten days for the individual lesions to heal, but in the meantime new and extremely painful ones developed. The patient had lost a considerable amount of weight. Before eating, she had to apply an anesthetic ointment to the lesions because of the pain associated with food touching them. A large number of therapeutic procedures had been tried on this patient, but none were successful.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: Two injections of gamma globulin, 5 c.c. each, were administered with an interval of three days between injections.

Result: The lesions that were present at the time of the initial injection healed readily, and the patient was free of them for a month. A small lesion then started to develop, and 10 c.c. of gamma globulin was administered. The patient was then completely free of lesions for seven months. In the following six months, she developed a few small, nonpainful lesions that healed within a few days.

CASE 9.—A 29-year-old man gave a history of occasional "cold sores" until a year prior to admission to our clinic. During that year, he developed painful oral lesions with increasing frequency. The individual lesions healed within five to seven days, but crops of new ones appeared before the older ones healed. The patient had not been without lesions for the last one and one-half years. It was extremely painful for him to eat, and his speech was greatly hampered by the oral pain. The only previous therapy that had provided slight temporary relief was the administration of ACTH, but a continuation of this therapy had proved to be of no help to the patient.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: Two injections of 10 c.c. gamma globulin were given twelve days apart.

Result: The first injection did not provide any relief of the symptoms. Following the second injection all of the lesions healed in a few days. Two weeks later some smaller, less painful lesions appeared. We were unable to contact the patient for further information.

CASE 10.—A 30-year-old woman had a history of very painful oral lesions which were almost continuously present for a period of three years. The individual lesions healed in three to seven days, but in the meantime new ones would have developed. Psychic stress seemed to aggravate the condition.

Diagnosis: Recurrent herpetic gingivostomatitis.

Therapy: An initial dose of 10 c.c. gamma globulin was administered and followed by three doses of 5 c.c. over a period of one and one-half months.

Result: No appreciable improvement could be observed following this therapy. The patient stated that her lesions were less painful since the treatment. The time of observation has been one year.

CASE 11.—A 45-year-old woman with a diagnosis of periadenitis mucosa necrotica recurrens was experimentally given two doses of 10 c.c. gamma globulin. No improvement in the patient's condition resulted from this therapy.

SUMMARY AND DISCUSSION OF FINDINGS

Ten patients with refractory recurrent herpetic gingivostomatitis have been treated with intramuscular injections of pooled gamma globulin. The dosages varied from 5 to 10 c.c., and each patient was given a total of 10 to 25 c.c. of gamma globulin. The time of observation following therapy varied from a few days to one and one-half years. Most patients were observed for six months to one year. Nine of the ten patients temporarily experienced complete relief from their oral lesions following the therapy. These asymptomatic periods lasted in one case for only a few days, in most cases for two to three months, and in a few cases for six to twelve months. When the oral lesions recurred, they were smaller and less painful than those which existed prior to administration of gamma globulin. The immunity against the herpetic lesions lasted for several months in the patients who had a relatively mild degree of the disease. The one patient who did not experience any appreciable improvement of her oral lesions had more severe, widespread, and painful lesions than the other patients.

Much more research is needed to determine proper dosage and duration of immunity. It appears advisable to give an initial dosage of 10 c.c. of gamma globulin and to repeat that dosage after intervals of five to seven days until relief of symptoms is obtained.

A trial administration of 20 c.c. of gamma globulin to a patient with periadenitis mucosa necrotica recurrens was not followed by any change in this disease, which is of unknown etiology.

CONCLUSION

Nine out of ten patients experienced various degrees of relief from recurrent herpetic gingivostomatitis following administration of gamma globulin.

ADDENDUM

Continued investigation during the year that has elapsed since this manuscript was prepared has confirmed the reported findings. However, initial

dosages of less than 10 c.c. (in one or two injections) have not been of any appreciable therapeutic value, and less than 5 c.c. at one time has been inadequate for maintenance therapy.

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PHARMACOLOGY AND THERAPEUTICS

TRIAMCINOLONE ACETONIDE IN THE TREATMENT OF ACUTE AND CHRONIC LESIONS OF THE ORAL MUCOUS MEMBRANES

Preliminary Report

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THERE are numerous acute and chronic lesions of the oral mucous membranes (including, among others, desquamative gingivitis and stomatitis, erosive lichen planus, geographic tongue, denture stomatitis, recurrent ulcerative stomatitis, cheilosis, and erythema multiforme) which have been the subject of intensive clinical investigations in efforts to obtain consistently effective cures or, failing in that, uniformly beneficial symptomatic relief. Previous therapeutic efforts in many of these diseases have been relatively inadequate, although an occasional patient has responded well to one agent or another.

Topical oral therapy with synthetic corticosteroids has been found moderately useful in controlling some of these lesions.[1-3] The more dramatic responses have been obtained in the treatment of more severe acute lesions or acute exacerbations of chronic lesions. The risk of systemic action of the absorbed steroid is more likely justifiable under such conditions. It was felt, nevertheless, that perhaps increasingly consistent beneficial results might be obtained with a newer corticosteroid, triamcinolone acetonide.

It is our purpose in this article to describe the results of therapy which we have observed in patients with various acute and chronic lesions of the oral mucous membranes through the use of triamcinolone acetonide prepared in a new adhesive vehicle, the latter[4] specifically designed for the application of therapeutic agents to oral mucous membranes.

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Triamcinolone acetonide (Kenalog) in a new adhesive vehicle (Orabase) was supplied by The Squibb Institute for Medical Research, New Brunswick, New Jersey.

Triamcinolone acetonide, a synthetic corticosteroid derived from triamcinolone, has been observed to be a particularly active topical agent, although it is also a fully active corticosteroid when administered systemically. Some of the pharmacologic data on triamcinolone acetonide follow.

Pharmacologic Data on Triamcinolone Acetonide.—The initial five-day cotton-pellet test in adrenalectomized rats indicated that triamcinolone acetonide possesses anti-inflammatory activity equal to about twenty times that of hydrocortisone acetate. In a later test, triamcinolone acetonide had thirty-five times the activity of hydrocortisone, ten times the activity of prednisolone, and ten times the activity of triamcinolone alcohol as an anti-inflammatory agent in animals.[5]

Triamcinolone acetonide has shown a potency over ninety times that of cortisone, twenty times that of hydrocortisone acetate, and greater than nine times that of triamcinolone alcohol in glucocorticoid activity[5] by the rat-liver glycogen assay.

No sodium retention has been observed in animals treated with triamcinolone acetonide; rather, such therapy has resulted in sodium excretion.

Triamcinolone acetonide was administered[5] orally to five patients with rheumatoid arthritis in doses ranging from 1 to 10 mg. per day for periods of one week to two months. All the patients had previously been satisfactorily maintained relatively free from signs and symptoms of the disease with prednisone in doses of 7.5 to 15 mg. per day. In two patients, triamcinolone acetonide was as effective as prednisone in controlling signs and symptoms of the disease (in one patient, at a dosage level of less than 1 mg. per day), while in the other three patients, this steroid in the dosage employed was less effective. Except for drowsiness, anorexia, and a loss in weight (4 to 5 pounds) over a period of one month in one patient, no undesirable or untoward effects of administration of triamcinolone acetonide were reported. No clinical evidence of significant electrolyte disturbance was reported.

Triamcinolone acetonide was administered[6] to four children (aged 5½ to 9 years) in relatively massive single oral doses (30 to 50 mg.). Suppression of 17-ketosteroid excretion (as measured in twenty-four-hour urine samples) as well as suppression of endogenous corticoid production (as measured by both the blue tetrazolium and Porter-Silber reactions) was observed. Maximum suppression of endogenous corticoid production occurred within twelve hours of dosing, and this suppression persisted for as long as thirty-six hours.

METHODS

Fifty-six patients, including eighteen males and thirty-eight females, ranging in age from 9 to 77 years, who were treated for various acute and chronic lesions of the oral mucosa are the subjects of this report. A definite diagnosis (where possible), as noted below, had been established in each patient prior to the institution of triamcinolone acetonide therapy. Many patients had previously been treated unsuccessfully with various therapeutic agents, including vitamins, sex hormones, antihistamines, topical anesthetics, topical antibiotics,

placebos, and protectants, and often with other corticosteroids, including prednisolone, hydrocortisone, triamcinolone, and fluorohydrocortisone. Thus, most patients served as their own controls. Acute nonrecurrent lesions, such as oral erythema multiforme and allergic stomatitis, were usually not "controlled" by placebo therapy.

There were six patients with erosive lichen planus, six patients with denture stomatitis (not of *Candida albicans* origin at the time of treatment), four with oral erythema multiforme (three allergic and one idiopathic), four with geographic tongue, eight with traumatic ulcers or denture irritations, two with chronic inflammatory lesions of unknown etiology, three with orolingual paresthesias, thirteen with recurrent ulcerative stomatitis, two with postradiation (cancer therapy) stomatitis, and eight with desquamative gingivitis or stomatitis. With regard to those patients with orolingual paresthesias and geographic tongue, therapy was undertaken with no expectation of a "cure."

Triamcinolone acetonide in the above-noted adhesive vehicle was applied by the patient to the areas in question four times daily in a 0.1 per cent concentration. Approximately 60 to 250 mg. of the medication was applied sparingly in the form of a thin film after meals and especially before retiring. Thus, about 240 to 1,000 mg. of medication, including 0.24 to 1.0 mg. of triamcinolone acetonide was applied to a lesion during the course of a day.

For further control purposes, the adhesive vehicle preparation was used as a placebo prior to therapy with triamcinolone acetonide in twenty patients as follows: three patients with geographic tongue, four with erosive lichen planus, four with recurrent ulcerative stomatitis, two with idiopathic orolingual paresthesia, two with denture stomatitis, three with desquamative gingivitis, one with idiopathic oral inflammation, and one with erythema multiforme.

RESULTS

Response to the Placebo Vehicle.—The application of the vehicle adhesive per se without triamcinolone acetonide resulted in some relief of symptoms, especially for that time during which the adhesive remained in situ. Occasionally, this observation was striking, owing very likely to the protectant properties of the adhesive. As the protectant dissolved, however, the original symptomatology returned promptly. No alteration in the total duration or in the clinical picture of the lesions was noted. This peculiar protectant action of the vehicle does, nevertheless, complicate to some extent the evaluation of any therapeutic agent incorporated in this vehicle.

Over-All Action of Triamcinolone Acetonide.—Triamcinolone acetonide in the adhesive vehicle was found to have either (1) suppressant, (2) ameliorative, or (3) curative effects on the various oral mucosal lesions enumerated above, with the exception of the three patients with idiopathic orolingual paresthesia and the four patients with geographic tongue. The terms "suppressant," "ameliorative," and "curative" are being used to indicate the following:

> (1) *Suppressant action:* A decrease in the clinically observable inflammation; with discontinuation of therapy, recurrence is anticipated, since the basic etiological problem remains essentially unaffected.

(2) *Ameliorative action:* A beneficial effect including, *or other than,* a suppressant action but with manifestations of subjective improvement.

(3) *Curative action:* Healing of the entire lesion; recurrence is not anticipated without further provocation.

Action in Specific Disease States.—

1. *Erosive lichen planus:* In each treated case, beneficial results of an ameliorative nature were obtained. The improvement was limited primarily to the erosive areas of lesions, the latter healing rapidly. Although in some few instances a depression of the lichenoid character was noted, it is difficult to assess this apparent effect at present.

2. *Denture stomatitis:* In all patients with intensive palatal inflammatory reactions under dentures, marked ameliorative effects were observed; in some instances, complete suppression of inflammation was obtained.

3. *Oral erythema multiforme:* All patients with ulcerative erythema multiforme were essentially "cured" following therapy with triamcinolone acetonide.

4. *Traumatic ulcers:* In all instances the traumatic ulcers treated with triamcinolone acetonide healed within a shorter period than is usually expected.

5. *Chronic inflammatory lesions:* In the cases of chronic inflammatory lesions of unknown etiology, there was considerable benefit but only through a suppressant action.

6. *Recurrent ulcerative stomatitis:* Triamcinolone acetonide had an ameliorative effect on lesions of recurrent ulcerative stomatitis in all patients. Triamcinolone acetonide was found to be effective in aborting lesions (if applied promptly following initial prodromal symptomatology) and in obtaining rapid healing or beginning epithelization of existing ulcers. In common with other corticosteroids, the administration of triamcinolone acetonide does *not* prevent the recurrence of lesions and does *not* result in any decrease in the size, severity, or duration of recurrent lesions unless the drug is readministered. The remission period between lesions is *not* increased if therapy is discontinued upon healing of a given crop of ulcers.

7. *Postradiation stomatitis:* A definite suppressant and ameliorative action was observed; this was followed ultimately by permanent disappearance of the lesions.

8. *Desquamative stomatitis:* A limited suppressant and ameliorative action was noted, but these effects were in no sense curative.

Duration of Therapy.—The duration of therapy generally required to produce the above-described effects for the various lesions was as follows: erosive lichen planus, seven to twenty-one days; denture stomatitis, three to seven days; oral erythema multiforme, four to ten days; traumatic ulcers, two to four days; chronic inflammatory lesions, seven to fourteen days; recurrent ulcerative stomatitis, three to seven days; postradiation stomatitis, seven to fourteen days; and desquamative stomatitis, seven to fourteen days. When acute nonrecurrent lesions were being treated, therapy was discontinued as soon as the lesion was

brought under control. Regimens making use of a lower concentration of the active agent (0.01 per cent), a single daily application (before retiring), and use of medication only when required are now being studied, especially with respect to chronic recurrent diseases.

Discontinuation of all therapy in chronic and recurrent disease states usually leads ultimately to substantial reappearance of the lesion and necessitates reinstitution of triamcinolone acetonide.

Side Effects.—No side effects of triamcinolone acetonide therapy were observed except for muscular "weakness" in two patients with recurrent ulcerative stomatitis treated for prolonged but discontinuous periods. This weakness, however, may be of considerable importance (see discussion).

DISCUSSION

It is to be emphasized that triamcinolone acetonide acted primarily as a suppressant and in the treatment of recurrent lesions did not prevent periodic exacerbations following withdrawal of steroid therapy. Furthermore, triamcinolone acetonide did not affect the characteristics or severity of such subsequently recurrent lesions unless the drug was readministered. Thus, permanence of cure (as we have defined "cure" previously) can be expected only in the treatment of such relatively acute lesions as erythema multiforme, traumatic ulcers, etc. Hence, triamcinolone acetonide therapy in common with other corticosteroids should be administered only with the full realization that its action is generally one of suppression rather than cure.

It should also be emphasized that triamcinolone acetonide is a fully active (systemically) corticosteroid and that the medication swallowed is made available for systemic action—a matter of advantage, disadvantage, or both. On a weight basis, triamcinolone acetonide is an extremely potent agent with powerful pituitary-suppressant activity. Hence, the duration of administration and total dosage must be accompanied by careful observation.

Inasmuch as the administration of triamcinolone acetonide is accompanied by possible systemic activity, it becomes important to utilize fully the advantages inherent in the vehicle in order to reduce to a minimum the total dosage of triamcinolone acetonide. It is essential, therefore, that the patient apply the preparation just prior to retiring at night in order to make the fullest use of the adhesive properties of this formulation. If the medication is to be applied only once during the day, the above time of administration is of even greater importance.

SUMMARY

Triamcinolone acetonide was administered in a new vehicle adhesive to fifty-six patients with various acute and chronic lesions of the oral mucous membranes. Trimacinolone acetonide therapy was undertaken in many instances after relatively prolonged unsuccessful therapy with numerous other agents and/or placebos. The patients treated included six with erosive lichen planus,

six with denture stomatitis, four with oral erythema multiforme, four with geographic tongue, three with orolingual paresthesias, eight with desquamative gingivitis or stomatitis, thirteen with recurrent ulcerative stomatitis, eight with denture irritations or other traumatic ulcers, two with chronic inflammatory lesions of unknown etiology, and two with postradiation (cancer therapy) stomatitis.

Triamcinolone acetonide in the adhesive vehicle was found to have either (1) suppressant, (2) ameliorative, or (3) curative effects on the various oral mucosal lesions enumerated above, with the exception of the three patients with idiopathic orolingual paresthesia and the four patients with geographic tongue.

Further studies with this agent in acute and chronic lesions of the oral mucous membranes, especially when combined with the new adhesive vehicle, seem indicated.

Since triamcinolone acetonide is a powerful corticosteroid which is fully active systemically, the total dose administered and the duration of therapy must be considered carefully. It is also essential that, where possible, therapy be of a discontinuous nature and that particular advantage be taken of the adhesive vehicle's ability to maintain a drug at the site of application.

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630 WEST 168TH ST.

ANESTHESIOLOGY

SYNERGISTIC BASAL NARCOSEDATION

A Basic Technique Employing Promethazine, Meperidine, and Secobarbital

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ALTHOUGH many pharmaceutical agents developed for use in the field of anesthesiology have great margins of safety, the administration of any general anesthetic is not without certain dangers. In dental procedures particularly, the effects of such anesthetics can be more serious than the operation. For this reason, discretion must be used in determining the method of pain control. Local anesthetics are the preparations of choice in the majority of dental and oral procedures upon the ambulatory patient. There are, however, those for whom the use of local anesthetics is contraindicated, as the handicapped and others who present physical and psychological problems.

Endodontic, periodontal, and other operations upon the mouth have evolved to such a high degree of complexity that treatment sessions of two and three hours' duration are not uncommon. There is a genuine need for a safer technique for anesthetizing the ambulatory dental patient when the use of local anesthesia is not possible.

A method—better described, perhaps, as a philosophy of patient care—which provides various degrees of anesthesia from light sedation to the surgical planes with maximum safety is outlined herein. Because it is relatively simple, it is of broad practical application and may be used even for the aged, the debilitated, and the prepartum patient. The basic technique is elastic and uncomplicated. However, a sound knowledge of the principles and practices of anesthesiology is essential. The method cannot be used for procedures of short duration, since the recovery time will be greater than that desired for brief operations. It should be used only for patients who require anesthesia for ninety minutes or more.

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The successive stages of cerebral depression produced by a general anesthetic are (1) sedation, (2) hypnosis, and (3) anesthesia.[1] The purposes of basal anesthesia are as follows[2]:

1. Psychic sedation to counteract fear and to depress reactivity of the central nervous system and thus reduce the requirement of the principal anesthetic.
2. Relief of pre- and postoperative pain.
3. Reduction of reflex irritability and the metabolic rate.
4. Counteraction of adverse side effects of the principal anesthetic.

The terms employed in the technique to be described are defined as follows:

Sedative: An agent that reduces excitement or agitation.

Hypnotic: A preparation that induces sleep.

Analgesic: A drug that relieves pain.

Anesthetic: A substance which, after administration by inhalation or injection, produces total or local loss of sensation.

Narcotic: A compound capable of producing deep sleep and insensibility.

Amnesic: An agent that erases memory.

Synergistic basal narcosedation: A state induced by a combination of agents which frees the patient from apprehension and excitability and places him in a semisomnolent, amnesic condition conducive to induction of general or local anesthesia with much smaller amounts of anesthetic agents than are ordinarily required.

The criterion which distinguishes the somnolence of sedation or hypnosis from that of anesthesia is arousability.[3] Under narcosedation, the patient will sleep peacefully while unmolested but will react to external stimuli.

METHOD

In the production of narcosedation, the following basic agents in synergistic combination are essential: promethazine, which allays apprehension, agitation, and fear[4] and induces a degree of amnesia; meperidine; and secobarbital sodium. Secobarbital sodium,* a short-acting barbiturate, depresses the cerebrospinal axis and, in overdoses, the respiratory centers also. In appropriate dosage, it may be used as a sedative, a hypnotic, or an adjunct to an anesthetic, but it is contraindicated for debilitated patients or for those who have liver disease. Used alone, it is not a good intravenous anesthetic. The dose required to produce anesthesia is too large, its action is too prolonged, and the margin of safety is too narrow. Intravenous injection must be slow—not more than 50 mg. per minute. Doses of 200 mg. will produce hypnosis[5] rather than anesthesia.

Meperidine hydrochloride,[4] a synthetic narcotic, materially raises the pain threshold but possesses only one-fifth the analgesic potency of morphine. This

*Secobarbital sodium is available as Seconal sodium from Eli Lilly and Company, Indianapolis, Indiana.

TABLE I. REPRESENTATIVE CASES

AGE	SEX	WEIGHT	OPERATIVE PROCEDURE AND DURATION	ANESTHETIC			BLOOD PRESSURE			PULSE			PRIMARY REACTION TIME (MINUTES)	TOTAL REACTION TIME (HOURS)	SIDE EFFECTS
				DOSE P-M UNITS*	SECOBARBITAL (MG.)	OTHER	PREOPERATIVE	DURING	POSTOPERATIVE	PREOPERATIVE	DURING	POSTOPERATIVE			
19	F	105	Two impactions, 90 min.	75		Lidocaine	135/85	135/82	130/78	108	88	90	105	5	Thirst
17	F	143	Four impactions, 125 min.	87.5		Lidocaine atropine	138/80	135/100	122/70	72	72	76	115	6	Thirst, itchy nose
37	F	132	Operative, crown and bridge, 135 min.	100		Lidocaine	130/82	136/84	124/78	106	86	84	145	7½	
17	F	115	Operative, 150 min.	75		Nitrous oxide-oxygen Lidocaine	138/98	138/98	134/90	88	80	82	150	5	Itchy nose and eyes
59	M	155	Reduction of mandibular fracture, 120 min.	115		Procaine	138/88	128/84	122/80	80	84	78	150	6½	
25	F	141	Operative, 105 min.	125		Lidocaine Nitrous oxide-oxygen	110/72	112/70	108/70	82	78	72	110	7½	"Chest on fire" for 15 minutes postoperatively

18	F	145	Apicoectomy, 95 min.	100		Lidocaine	130/80	122/80	132/86	72	72	68	110	6	Itchy nose
17	F	108	Two impactions, 90 min.	90	60	Lidocaine	106/80	106/76	104/70	104	92	88	95	7½	Thirst, itchy nose
25	F	146	Operative, endodontic, impactions, 150 min.	115	100	Nitrous oxide-oxygen, trichlorethylene	122/70	108/62	112/68	80	80	86	165	8½	Thirst, itchy nose
37	F	137	Surgical per. io., lip hemangioma removal, 130 min.	90	100	Lidocaine, nitrous oxide-oxygen, trichlorethylene	110/72	104/70	102/78	78	74	80	150	9	Transient phlebitis (12 hours)
33	F	121	Operative, crown and bridge, pulp canal, 180 min.	100	100	Nitrous oxide-oxygen, trichlorethylene	108/78	98/64	100/70	108	90	88	205	8	Thirst, itchy nose and eyes

*P-M unit = 1 mg. of the promethazine-meperidine combination.

compound does induce the classical clinical picture of narcosis, but it appears to dull pain perception by blocking the thalamic sensorium.[6]

Promethazine hydrochloride [N-(2′-dimethylamino-2′methyl) ethyl phenothiazine hydrochloride]* is a powerful, long-acting antihistamine which does not alter the autonomic mechanism. The sedative effect has been demonstrated in various fields of clinical medicine.[7] The compound has been combined with analgesics, such as meperidine, and occasionally with the barbiturates. For prophylaxis of postoperative complications in dental surgery, the same good results may be obtained with oral promethazine as with an antihistamine by injection. It has been reported that edema, pain, and trismus in operations on the mouth may be eliminated entirely or reduced materially by preoperative oral medication with promethazine.[8] Promethazine also reduces the need for sedatives and narcotics preoperatively and for inhalation and intravenous anesthetics and meperidine during surgical procedures. It makes it easier to anesthetize patients who have asthma and emphysema, and it is well tolerated by poor-risk patients.[9] Potent antiemetic properties have been reported by several workers.[7, 10, 11]

Of particular interest is the potentiating action of promethazine on barbiturates and narcotics.[1, 2, 7, 13-17] Narcotics and hypnotics may be used in conjunction with promethazine in approximately one-half the usual dosage with no loss in potency and considerable diminution of side effects. These combinations fulfill excellently the requirements of basal anesthesia.[7]

CLINICAL STUDIES

In developing the technique described in this article, we followed several paths of investigation. A total of 252 patients, divided into five groups, were studied. Group 1 received secobarbital alone; Group 2, meperidine alone; Group 3, promethazine alone; Group 4, meperidine and promethazine; and Group 5, a combination of promethazine, meperidine, and secobarbital. All medications were administered intravenously.

Operations of every type were performed under local or general anesthesia, or both. The eleven cases listed in Table I are representative.

In some cases from each of the five groups anesthesia was taken to the basal point (Table IV) and supplemented with local anesthesia, and other patients were carried into the surgical planes with nitrous oxide-oxygen and occasionally trichlorethylene. Pulse, blood pressure, reaction time, and other salient factors were recorded (Table II). The lapse of time from the initial intravenous injection to the point at which the patient again became ambulatory is described as the "primary recovery time." The "total recovery time" is the period required for the subsidence of all sedative effects.

Group 1. Secobarbital Only.—Twenty-seven patients, whose average weight was 140 pounds, received an average dose of 145 mg. of secobarbital only. Sedation and hypnosis were good, but analgesia was poor and there was little or no

*Phenergan hydrochloride (Promethazine hydrochloride), available from Wyeth Laboratories, Philadelphia, Pennsylvania.

TABLE II. PROMETHAZINE-MEPERIDINE-SECOBARBITAL

OPERATIONS	NUMBER OF PATIENTS	AVERAGE OPERATION TIME (MINUTES)	AVERAGE PRIMARY REACTION TIME (MINUTES)	LOCAL ANESTHESIA	GENERAL ANESTHESIA	TOTAL P-M UNITS*	TOTAL SECOBARBITAL (MG.)
Apicoectomy, fractures, impactions, alveolectomies, operations on soft tissues	22	96	102	7	15	91	84
Endodontics	4	126	138	3	1	114	90
Periodontics	3	138	150	0	3	121	98
Exodontia	7	85	100	2	5	86	81
Crown and bridge procedures—impressions	17	144	168	14	3	120	103
Restorative dentistry	18	115	127	8	10	103	92
Totals	71	117.3	131	34	37	106	92

*P-M unit = 1 mg. of the promethazine-meperidine combination.

amnesia. Respiration was badly depressed, tidal volume was decreased, and reductions in blood pressure of 20 to 25 mm. Hg were not uncommon. Although the medication acted rapidly and decreased the volume of general and local anesthetics required, primary and total reaction times were long, and "hangover" was pronounced.

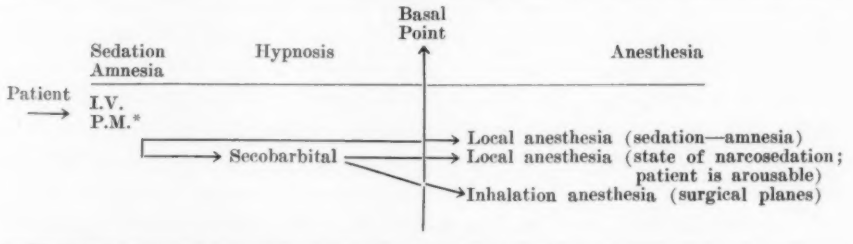
TABLE III. SUGGESTED DOSAGE TABLE

WEIGHT (LB.)	P-M UNITS*	SECOBARBITAL (MG.)
90	60- 75	50
100	75	50
125	85-100	60
135	100	75
150	100-115	100
Over 150	125	100-120

*P-M unit = 1 mg. of the promethazine-meperidine combination.

Group 2. Meperidine Only.—Thirty-four patients, all in good health and weighing an average of 132 pounds, received meperidine alone. To achieve the desired state of narcosis, an average of 98 mg. per patient was required. Analgesia was fair and amnesia was good. There was little respiratory depression or hypotension (the decrease in systolic blood pressure averaged 5 mm. Hg).

TABLE IV. LEVELS OF ANESTHESIA



*P.M. = Promethazine-meperidine

Seven patients received nitrous oxide-oxygen for general anesthesia. In these cases, the excitement stage was minimal, the dosage of oxygen was high, and the total amount of anesthetic required appeared to be less than that used in similar cases in which premedication was not used.

Group 3. Promethazine Only.—Thirty-two patients, ranging in age from 16 to 47 years and all in good health, received promethazine only. The average weight in this group was 127 pounds. The patients' apprehension was relieved, and most were mildly sedated. Although many of these patients received doses in excess of 100 mg. of promethazine, hypnosis developed in only a few. As a basal anesthetic, promethazine appeared inadequate alone (in an average dose of 88 mg.), since the patients generally appeared alert. Maximum doses of the anesthetic were required.

Group 4. Promethazine-Meperidine.—P-M units: Mixtures of promethazine and meperidine containing up to 50 per cent of promethazine yield a meperidine-like analgesia equal to that provided by the same total amount of meperidine alone. Each milligram of the combination is referred to as a P-M unit. In the average adult patient, 2 P-M units per 3 pounds of body weight provided the desired analgesic effect.

Eighty-eight patients, with an average weight of 135 pounds, received an average dose of 94 P-M units of the promethazine-meperidine combination. From these and other[11] studies, it would appear that 1 mg. of promethazine can be predictably substituted for each utilizable milligram of meperidine. The pharmacologic action is the same. Hence, for purposes of explanation only, in a combination of equal parts these agents are calibrated in P-M units, each unit equalling 1 mg. of promethazine or 1 mg. of meperidine. To achieve an adequate basal sedation, less than one-half as much meperidine (47 mg.) was required when used in combination with promethazine than when the narcotic was used alone (98 mg.). Alterations in blood pressure and pulse rate were minimal. Amnesia and analgesia appeared superior to that obtained with meperidine alone. Recovery time and total reaction time ("hangover") were shortened.

In nineteen of the cases in this group anesthesia was completed with nitrous oxide-oxygen, and in no instance was less than 30 per cent oxygen administered. In only one patient was supplementation of anesthesia with trichlorethylene required.

Group 5. Promethazine-Meperidine-Secobarbital.—Seventy-one patients, whose average weight was 137 pounds, received a combination of promethazine, meperidine, and secobarbital, in an average dose of 106 P-M units, and 82 mg. of secobarbital. Decrease in blood pressure was minimal (8 mm. Hg), pulse rate was substantially unaltered, and respiration was not materially depressed. Hypnosis and amnesia were good to excellent. Analgesia was fair.*

**Explanation of criteria:* The average patient was awakened only by a concentrated effort; therefore, hypnosis was considered good. He could remember little or nothing of the operation postoperatively, so amnesia was considered excellent. He reacted only to quite painful stimulation; hence, analgesia was adjudged fair.

The basal state was readily attained (Table IV), and smaller-than-average doses of anesthetic with greater-than-average amounts of oxygen were administered for completion of the operation. Primary recovery time averaged a little more than two hours, and the total recovery time averaged six and one-half hours.

TECHNIQUE FOR NARCOSEDATION

Observation of numbers of patients after administration of the various medications described led to the conclusion that the method used for Group 5 provided the ideal in narcosedation (Fig. 1).

Fig. 1.—Pharmacologic armamentarium required in narcosedation. *A*, Secobarbital; *B*, promethazine; *C*, meperidine.

The procedure is begun with the institution of an intravenous infusion of 500 c.c. of isotonic sodium chloride solution (Figs. 2 and 3). A primary or induction dose is introduced into the tubing in accordance with the schedule suggested in Table III. A dose of 100 P-M units has been arbitrarily established for the average 150 pound adult; this can be adjusted as desired. As little as 60 P-M units have been administered successfully. Experience with a few cases is usually sufficient for the anesthesiologist's guidance in gauging the most suitable amount for the initial injection in the individual patient (Fig. 4). An observation period of five minutes for evaluation of the results should follow the primary dose. Generally at this point the patient will report that he feels sleepy and cannot keep his eyes open. However, he is readily arousable and responsive to painful stimuli.

To gain the desired stage of *sedation* and *amnesia*, as much as 150 P-M units may be required. For *hypnosis*, however, secobarbital sodium should be

injected into the infusion tube* at the rate of 50 mg. per minute (Fig. 5). After each dose of 50 mg., two to four minutes should be spent in observation of the patient before additional quantities are added. It must be remembered that *promethazine enhances the activity of the barbiturates,* so that each dose of

Fig. 2.

Fig. 3.

Fig. 2.—The patient prepared for anesthesia; intravenous infusion begun.
Fig. 3.—Intravenous normal saline infusion.

secobarbital will probably exert twice the usual pharmacodynamic action. Usually, small P-M doses with secobarbital support are sufficient; 80 to 100 mg. of secobarbital will induce a deep hypno-amnesic state. Administration of a local anesthetic in most instances completes the preparation for operation.

*Secobarbital and promethazine should not be permitted to mix; a sticky, heavy white precipitate results.

No ambulatory patient should receive more than 150 P-M units in addition to 100 mg. of secobarbital sodium. If, after medication in this amount, the patient still shows some degree of unrest, that is, if he mumbles and casts his head and extremities about in a disturbed or impatient fashion, he is considered refractory to the technique and an inhalation anesthetic should be employed.

In almost all instances, the patient will lie in a light, quiescent sleep. Gag and pharyngeal as well as conjunctival and corneal reflexes are present. Since the patient is usually anesthetized locally, there is little or no stimulation to awaken him.

Fig. 4.

Fig. 5.

Fig. 4.—Addition of promethazine-meperidine.
Fig. 5.—Addition of secobarbital.

It is rarely necessary to carry the technique past the basal level (Table IV) at which point regional anesthesia is employed. When the surgical plane is desired, nitrous oxide-oxygen in equal proportions will generally suffice. This technique is nonexplosive and offers one of the easiest and safest methods possible. There is little or no alteration of the vital signs. Respiratory embarrassment does not occur when a patent airway is maintained with good

suction and a well-placed pharyngeal pack. Laryngospasm is practically unknown, and oxygen flow is rarely reduced to less than 50 per cent, which is of advantage to the patient who is a poor anesthetic risk.

A minimum of ninety minutes is available for the operation, and the patient can become ambulatory in two to two and one-half hours from the time of the initial injection. When necessary, however, he can be maintained under narcosedation for several hours by regulation of the original dose of the medication and by supplemental small doses as needed. The technique makes the patient so anesthetic-labile that very subtle changes of the oxygen flow will either deepen the plane of anesthesia or bring him out of the anesthetized state with ease, even after operations of two and three hours' duration. Most patients will react promptly to administration of 100 per cent oxygen through the nasal inhaler. Total recovery time averages seven to eight hours, during which the patient usually "sleeps off" the narcosedation at home.

Side effects from the medication are limited to itching of the nose and eyes, drowsiness, reduction in salivation (as expressed by postoperative thirst), and in one case there was a transient phlebitis. In surgical procedures of the mouth, dryness of the oral tissues is considered an added advantage.

DISCUSSION

The dental surgeon will find the intravenous route of medication simple, efficient, and possessed of several advantages. Administered by vein, drugs act quickly, are detoxified rapidly, and provide a more complete type of action, dose for dose, than is obtainable with other modes of administration.[1]

Narcosedation by the method described permits operation under local anesthesia. It can lay the pharmacologic groundwork for the general anesthesia required for more extensive procedures as well.

Although the method must be used only for operations of at least ninety minutes' duration, this can be an advantage, since it permits performance of several simple procedures in one visit. For example, the patient who requires five or six amalgam restorations, some simple periodontic therapy, or perhaps an extraction can have all these services planned as one operation and, under these circumstances, synergistic narcosedation is indicated. For complicated cases requiring periodontal treatment, multirooted pulp canal therapy, crown and bridge preparations, or oral surgical procedures, narcosedation is ideal.

The technique has been employed without untoward results for operations of more than two hours on prepartum women in the middle trimester, on patients with mild cardiac disorders, and on patients with controlled diabetes.

SUMMARY

An elastic, universally applicable technique for narcosedation is the culmination of a new philosophy for the anesthetic management of the ambulatory dental patient and is particularly advantageous for those who have physical or psychological problems. The method employs promethazine and meperidine, supported with secobarbital, by intravenous injection and thus

provides synergistic basal narcosedation with extraordinarily small doses of meperidine, the barbiturate, and the indicated anesthetic agent. The method permits performance of operations of ninety minutes or more under local anesthetics in small amounts, or induction of any stage of general anesthesia from analgesia to the surgical planes required for more extensive oral procedures, without the excitement characteristic of inhalation anesthesia produced by conventional methods.

Following a clinical trial of various methods for preanesthetic medication in 252 patients, seventy-one patients successfully underwent dental procedures after they had received intravenous basal narcosedation with the three agents described. Advantages are maximum safety; desirable antihistaminic and antiemetic action; prolonged anesthesia produced with smaller-than-usual dosage of the anesthetic agent and readily maintained with high levels of oxygenation; rapid initial recovery time; and minimum effect on vital functions.

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ROENTGENOGRAPHY OF ENAMEL

Apatite as a Phantom Material; Contrast as a Function of Exposure Factors

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INTRODUCTION

THE purposes of this investigation were (1) to introduce hydroxyapatite as a phantom material for use in studies of roentgen-ray penetration of enamel and (2) to observe differences in roentgenographic contrast at a variety of exposure factors.

Investigators of roentgen opaqueness of oral structures have utilized step wedges of aluminum, of aluminum alloys, and of ivory,[1-3, 5, 6] all of which closely approximate roentgen-ray attenuation of dentine. The search for an equally good phantom for the simulation of the coefficient of roentgen-ray attenuation by human enamel led to the selection of hydroxyapatite [$Ca_{10}(PO_4)_6$ $(OH)_2$].[4]

MATERIALS AND METHODS

It was assumed that in clinical practice a carious defect in the enamel should be best demonstrated roentgenographically by utilizing the exposure factors which would result in the greatest possible contrast between the image of the area of the defect and the image of the surrounding intact enamel. Roentgenographic contrast was assumed to be definable as differences in photographic densities.

The plan was to obtain roentgenograms of a suitable phantom at a wide variety of exposure factors, to select the films showing the greatest contrast,

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and then to adopt a clinical viewing procedure that would permit utilization of the exposure factors shown to have produced the highest photographic density differences.

From the examination of human material, it was found that at the dentinoenamel junction, on the mesial, distal, or occlusal surfaces, large molar teeth presented a buccolingual enamel thickness of as much as 12.5 mm. With this as the maximum thickness, an apatite wedge of ten steps was assembled, each step being approximately 1 mm. (Fig. 1, *A* and *B*).

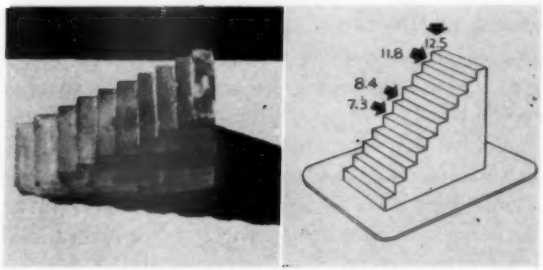

Fig. 1.—*A*, Step wedge of hydroxyapatite [$Ca_{10}(PO_4)_6(OH)_2$] with steps of approximately 1 mm. each.

B, In the experiment the wedge was placed on a film and roentgen rays were directed perpendicularly from above. Results reported pertain to steps 12.5 and 11.8 mm. (the equivalent of a defect of 0.7 mm. in a tooth having a buccolingual enamel thickness of 12.5 mm.) and to steps 8.4 and 7.3 mm. (the equivalent of a defect of 1.1 mm. in a tooth having a buccolingual enamel thickness of 8.4 mm.).

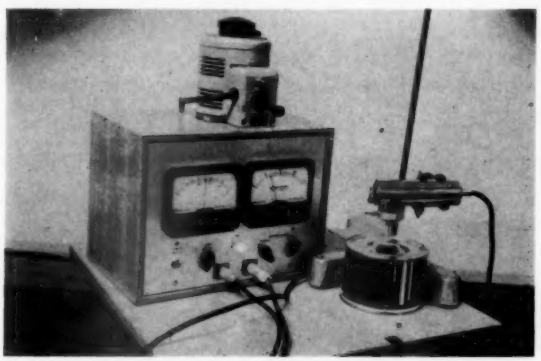

Fig. 2.—Densitometer adapted from a scintillation probe (Townsend Instrument Company), with a No. 17 hypodermic needle (point cut off) as the viewing aperature. The light source was a line-operated six-volt lamp (National Light, Catalogue No. 1700), controlled by a Powerstat variable transformer (Type 116, Superior Electric Company). The phototube of the probe was connected to a high-voltage supply and to a current amplifier, each with a meter. The current meter markings were in divisions of from 0 to 100. Diffusion of light was obtained by placing two layers of onionskin paper over an opening in the top of the lamp housing.

Roentgenograms of the wedge were taken at kilovoltages of 50, 66, 90, and 120. The milliampere-seconds of exposure were varied from 3.3 to 400 to provide films ranging from obvious underexposure to gross overexposure at each of the four kilovoltages. All films in the final series were exposed during one work period, and all were processed at the same time. The amount of irradiation for each film was recorded in roentgens.

Objective recordings of photographic densities on the film strips were obtained by the use of a densitometer (Fig. 2).

To obtain a comparison of the photographic densities of a pair of steps on a roentgenogram of the phantom, the procedure was to adjust the densitometer to give a reading of 100 when centered on the image of the thicker of the pair of steps being studied, the adjustment being in either (1) the brightness of the light by means of the autotransformer, (2) the voltage on the phototube, or (3) both. Light transmission through the roentgen image of the thinner step of the pair being studied could then be read as a direct percentage of the light transmitted through the image of the thicker step.

To obtain the absolute photographic density of any step on a roentgenogram of the phantom, the procedure was as follows: The standard of comparison was a Kodak step-film No. 2 which was calibrated with a Kodak color desitometer. The step to be evaluated was compared with the Kodak step-film and selection was made from the Kodak step-film of an image whose photographic density was equal to or just greater than the image from the phantom. These two images were then examined densitometrically, as described in the preceding paragraph, and the percentage of light transmitted was recorded. From the known density of the calibrated Kodak film was subtracted the difference in photographic density between it and the phantom image, the amount to be subtracted being the $\log \frac{100}{I^n}$ where I^n is the percentage of transmission of light through the darker step relative to that of the lighter step.

PER CENT DLT	FN	KVP	Ma.S.	AD 12.5 MM.	AD 11.8 MM.	DD	DOSE
92	73	120	20	2.67	2.95	0.28	1.90
80	67	90	50	2.40	2.66	0.26	2.50
51	70	120	10	1.47	1.65	0.18	0.94
26	65	90	20	1.15	1.25	0.10	0.97
13	58	66	50	0.64	0.70	0.06	1.10
8	80	50	400	0.74	0.78	0.04	3.40

Key to abbreviations:

Per cent DLT = Percentage difference in light transmitted through the roentgen image of step 12.5 as compared to step 11.8 mm.
FN = film number
KVP = Peak Kilovoltage
Ma.S. = Milliampere seconds of exposure
AD 12.5 mm. = Absolute photographic density of the image of step 12.5 mm.
AD 11.8 mm. = Absolute photographic density of the image of step 11.8 mm.
DD = Difference (added) in density between the images of steps 12.5 and 11.8 mm.
Dose = Irradiation (in roentgens)

Fig. 3.— Selected data from the study of steps 12.5 and 11.8 mm. of the apatite step wedge.

RESULTS

Objective Examination.—Selected data from steps 12.5 mm. and 11.8 mm. of the apatite phantom are shown in Fig. 3; these data pertain to the two best films at 120 and 90 kilovolts and to the best film at 66 and 50 kilovolts. The greatest contrast obtained between the roentgen images of these two steps was

in film 73. This contrast, expressed as a percentage difference in light transmitted, was 92; expressed as a difference in photographic densities, the contrast was 0.284. The best film obtained at 50 kilovolts required an impractical 400 milliampere-seconds of exposure and resulted in a percentage difference in light transmitted of only 8 and a density difference of only 0.036.

From the study of steps 8.4 and 7.3 mm. of the apatite phantom, selected data are shown in Fig. 4; these data pertain to the two best films at 90 and 120 kilovolts and the best film at 66 and 50 kilovolts. The greatest contrast obtained in the study of these two steps was in film 66. This contrast, expressed as a percentage difference in light transmitted, was 149; expressed as a difference in photographic density, the contrast was 0.396.

PER CENT DLT	FN	KVP	MA.S.	AD 8.4 MM.	AD 7.3 MM.	DD	DOSE
149	66	90	31.5	2.67	3.07	0.40	1.6
122	70	120	10.0	2.46	2.81	0.35	0.9
99	65	90	20.0	1.96	2.26	0.30	0.97
92	71	120	7.5	2.03	2.31	0.28	0.71
92	58	66	50.0	1.29	1.57	0.28	1.1
54	78	50	100.0	0.71	0.90	0.19	0.85

Fig. 4.—Selected data from the study of steps 8.4 and 7.3 mm. of the apatite phantom. (For explanation of column headings, see Fig. 3.)

Subjective Examination.—Without knowledge of the densitometric data, two of us (B. R. and W. G.) made a subjective study of all films. There was no instance of disagreement between the subjective findings and the densitometric measurements. When the darker films were viewed, however, it was necessary to increase the illumination greatly and to eliminate extraneous light by reducing the viewing field to a circle approximately ¼ inch in diameter.

The viewing apparatus used when special light was required is shown in Fig. 5.

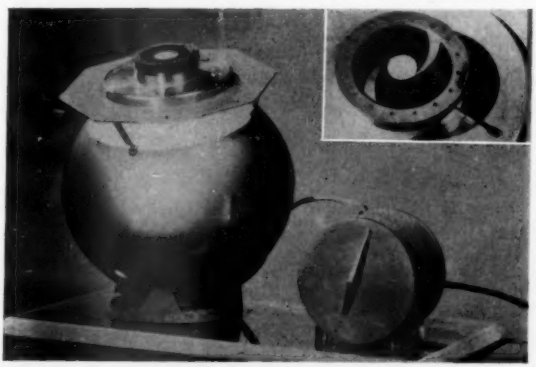

Fig. 5.—Viewing apparatus for roentgenograms having high photographic densities: General Electric photo enlarger bulb (No. 213) in a General Electric spot-viewer, a transformer for varying the intensity of the light, and a diaphragm for changes in aperture size. The iris of the diaphragm was protected above by a piece of optical-quality glass. The film was protected from heat by a piece of quartz glass below the diaphragm.

As compared to an initial lumens of 410 from a standard General Electric T-12, 14-watt, daylight fluorescent lamp, the 213 photo-enlarger bulb produces 7,000 initial lumens at 120 volts.

COMMENTS

It seems apparent that the roentgenography of enamel may best be studied by using apatite as a phantom material, since its roentgen-ray attenuation is practically identical to that of enamel.

The study indicates that even totally impractical milliampere-seconds of exposure will not compensate for voltages that are too low. The results suggest that there may well be an ideal voltage for a given thickness of enamel, and it is possible that voltages above 120 might have clinical application.

Regardless of voltage selection, it seems obvious that greater film densities provide greater contrast. The better films in this series all had intact enamel images of photographic density between 2 and 3. The use of films of such high density demands the use of a high-intensity source of illumination (as high as 7,000 lumens compared to the usual 410), controlled by a variable transformer and equipped with a variable-sized viewing aperture to eliminate extraneous light.

It would seem that the roentgen study of enamel requires exposure factors different from those commonly used for periapical projections. A comparable situation in medical roentgenography is presented by the difference between the voltage (65) used for routine chest and abdomen films and that used for a roentgenogram of the same area (120) when barium is employed as a contrast medium.

CONCLUSIONS

1. Roentgenograms produced with usually recommended exposure factors lack precision in the depiction of caries in enamel as a result of underpenetration and of inadequate film density.

2. To produce the greatest possible contrast between the roentgen image of a carious lesion and the image of surrounding intact enamel, the voltage used should be sufficiently high to ensure adequate penetration. The study indicates a need for dental roentgen-ray equipment with a peak kilovoltage of at least 120.

3. Assuming proper voltage, contrast is greatest in roentgenograms in which the image of the intact enamel has a photographic density between 2 and 3.

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APPENDIX

A TYPICAL PROTOCOL

Thickness of apatite steps being studied: 12.5 and 11.8 mm.
Roentgen generator: General Electric Maxiscope
Filtration: 2 mm. of aluminum
Target-film distance: 16 inches
Film: Eastman Ultra-Speed (DF58)
Kilovolt peak: 90

Exposure factors:

FILM NUMBER	Ma.S.	DOSE (ROENTGENS)
60	3.3	0.165
61	5.0	0.250
62	7.5	0.375
63	10.0	0.500
64	15.0	0.750
65	19.5	0.970
66	31.5	1.600
67	50.0	2.500

Densitometric data:

FILM NUMBER	PER CENT OF LIGHT TRANSMITTED THROUGH IMAGE OF STEP 11.8 AS COMPARED TO STEP 12.5	ABSOLUTE DENSITY OF STEP 12.5	ABSOLUTE DENSITY OF STEP 11.8	DIFFERENCE (ADDED) IN DENSITY BETWEEN STEPS 12.5 AND 11.8	PER CENT DIFFERENCE IN LIGHT TRANSMITTED
60	96.9	0.36	0.38	0.016	104
61	94.0	0.46	0.49	0.027	106
62	88.0	0.60	0.66	0.056	114
63	87.0	0.69	0.75	0.060	115
64	82.5	0.90	0.98	0.084	120
65	79.0	1.15	1.25	0.101	127
66	63.0	1.76	1.96	0.200	159
67	55.5	2.58	2.84	0.256	180

Subjective examination: Film 67 was selected as showing the greatest contrast between images of steps 12.5 and 11.8 mm. Selection was made with the special viewing apparatus shown and described in Fig. 5.

DENTAL X-RAY EQUIPMENT OF THE FUTURE

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Just as the design of dental x-ray equipment has changed during the past forty years, additional changes will be made in the years ahead. The following paragraphs will describe changes in the design of dental x-ray equipment which may very well become the realities of tomorrow.

An increasing number of dental offices have more than one operating room and, therefore, have a need for more than one x-ray unit. The convenience of having x-ray equipment in each room must be weighed against the considerable cost of owning more than one complete dental x-ray apparatus. This convenience could be obtained more economically if an x-ray head were installed in each operating room and all were powered from the same set of controls. One manufacturer already offers the two components of the x-ray apparatus for sale separately.

The dental x-ray equipment of the future probably will be designed to operate with voltages no higher than 90 kilovolts peak. Some dentists prefer to have their x-ray units operate at fixed values of current and voltage for the sake of simplicity in operation, whereas other dentists appreciate the flexibility in technique which is possible through the variable control over the factors of current and voltage. Manufacturers undoubtedly will continue to provide equipment to meet both of these demands.

As the trend toward the use of high-speed films continues, and as the speed of dental films is increased throughout the coming years by the manufacturers of film, the exposure times will become even shorter. To avoid these extremely short exposure times, which can be controlled accurately only by very expensive timers, the x-ray equipment of tomorrow may be designed to operate with less current. As the tube's current decreases, there arises the interesting possibility that the size of the focal spot of the x-ray tube may shrink, thus producing better definition of details in the roentgenograms produced. The consequences of the reduced electrical load also may be reflected in the simpler design and longer life of future dental x-ray units.

The use of electronic and synchronous motor timers probably will be continued in the future. The method of setting and triggering these timers will be discussed later.

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It is doubtful that radioisotopes will replace the x-ray tube as the source of radiation in the dental x-ray apparatus. As yet no long-lived radioisotope has been found which emits enough radiation with the proper energies to be practical in dental radiography.

Roentgenograms made with an extended distance between the x-ray tube and film exhibit better definition and less enlargement than those made at shorter distances; this has been proved mathematically.[1] The previous statement is true regardless of the method used for positioning the film packet in the mouth of the patient. Furthermore, when two identical roentgenograms are made, one with an extended distance between the x-ray tube and the film and the other with a lesser distance, the dose of x-radiation to the skin in the former example is less than in the latter.

To achieve an extended distance between the x-ray tube and film today, a long cone must be fastened onto the head of the x-ray unit in place of the usual short, pointed cone. This long cone often proves to be very cumbersome for use in small dental offices. Usually the x-ray apparatus is mounted a short distance from the left side of the dental chair. When a long cone is used with some present-day x-ray equipment, it is impossible to stretch the extension arm far enough to reach the right side of the patient's face. This difficulty usually is surmounted by rotating the chair and the patient.

The head of an x-ray unit is basically a metallic tank which contains an x-ray tube and other electrical components completely surrounded by an electrically insulating medium. The x-ray tube is located just a short distance behind the plastic cone at the front of the tank (Fig. 1, *A*). At the base of the plastic cone are located an aluminum filter and a diaphragm made of lead. In Fig. 1, *A* the tip of the short, pointed cone is just 7 inches from the focal spot of the x-ray tube. The open end of the long cone is 15 inches from the focal spot of the x-ray tube, as indicated in Fig. 1, *B*. In both illustrations, the circular aperture in the lead diaphragm limits the diameter of the primary x-ray beam to 2¾ inches at the end of the cone.

It is possible that future dental x-ray equipment may be designed with the x-ray tube located near the back of the tank, as illustrated in Fig. 1, *C*. Numerous advantages could be realized with the x-ray tube in this new position.

With this new design, it would be possible to operate routinely at the extended distance normally afforded only by a long cone. However, the length of the visible portion of the cone would be the same as the conventional short cone. The remainder of the extended distance between the focal spot of the x-ray tube and the end of the cone would be hidden within the head of the x-ray apparatus. With this new design, the cumbersomeness of the long cone would be eliminated, while the advantages of better definition, less enlargement, and reduced dosage to the skin would be retained. This modified design would bring the right side of the patient's head within range of the normal extension arm.

It has been demonstrated, by roentgenograms made with a lead-lined pinhole camera,[2] that considerable secondary radiation originates at the aluminum filter of dental x-ray equipment. This radiation scatters in all directions, and some

passes through the aperture in the lead diaphragm and exposes the patient and the dentist. The closer the filter is located to the aperture in the lead diaphragm, the larger will be the area on the patient that is exposed by his scattered radiation from the filter.

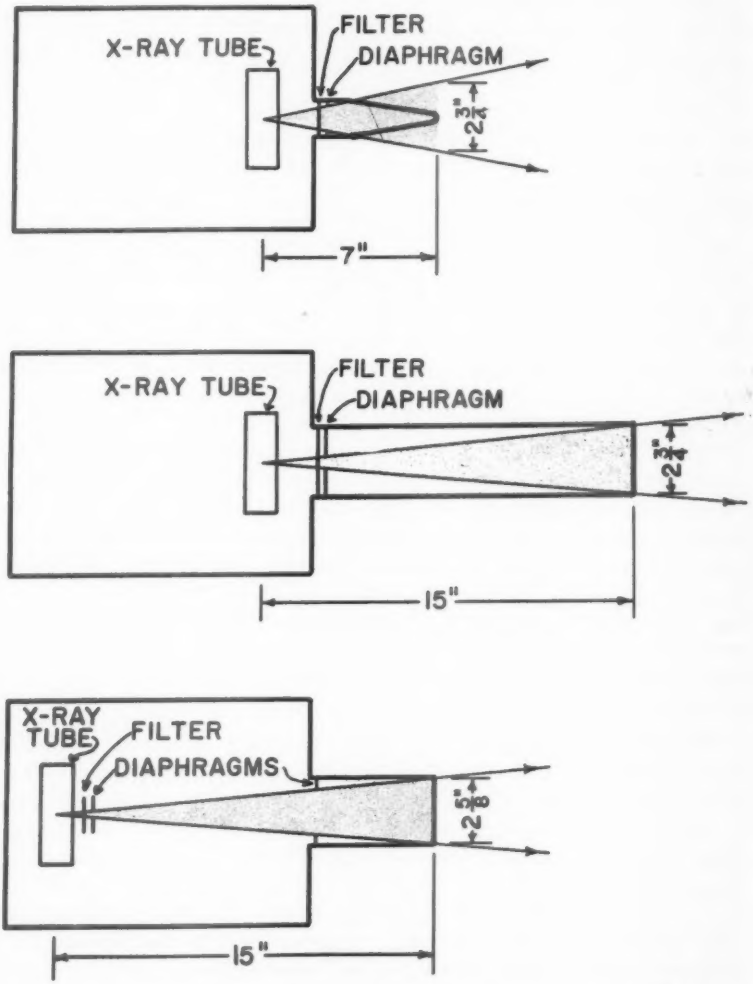

Fig. 1.—*A*, Diagram of head of conventional dental x-ray apparatus with short, pointed cone. *B*, Diagram of head of conventional dental x-ray apparatus with long, open-ended cone. *C*, Diagram of head of future dental x-ray apparatus with x-ray tube moved to new position.

Fig. 2 illustrates the sources of radiation which expose the region of the patient's gonads while his maxillary central incisors are exposed by x-rays. The large, dark, circular spot in this illustration indicates that the filter contributes

considerably to the total exposure of the gonads. The pointed plastic cone also is shown to emit scattered radiation along with the nose and anterior portion of the patient's face.

In Fig. 1, *C* it is seen that an aluminum filter and an initial diaphragm of lead are located deep within the head of the x-ray unit. This arrangement would limit the area of the patient exposed to the radiation that is scattered by the filter to almost the same area of the patient that is exposed to the primary x-ray beam.

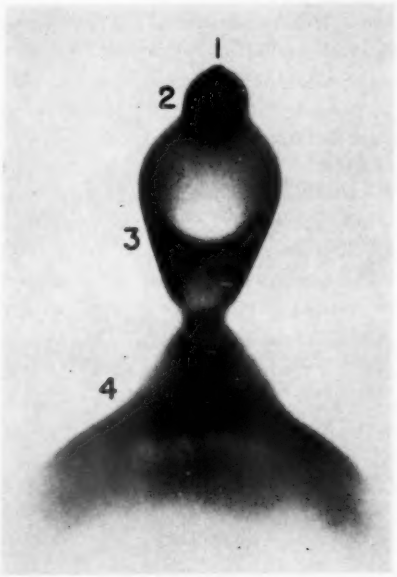

Fig. 2.—Roentgenogram made with a pinhole camera showing the sources of radiation that expose the reproductive organs of the patient. *1*, Leakage of radiation from focal spot of x-ray tube. *2*, Radiation which scattered from aluminum filter and emerged through aperture in lead diagram. *3*, Radiation which scattered from that portion of pointed, plastic cone which was exposed to the primary x-ray beam. *4*, Radiation which scattered from those portions of the patient's nose, face, and chin which were exposed to the primary x-ray beam.

The scattered radiation from the pointed cone can be eliminated by replacing the pointed cone with a cone which is open at the end. The open-ended cone will not emit scattered radiation, for its walls will not be irradiated by the primary x-ray beam.

The exposure of the patient's face to x-radiation can be decreased by reducing the cross-sectional area of the primary x-ray beam. A reduction of over 22 per cent in the cross-sectional area of the primary x-ray beam can be realized by changing from a round beam, 2¾ inches in diameter, to a rectangular beam measuring 1¾ inches by 2⅝ inches.

In Fig. 1, *C* the second diaphragm, which is at the base of the open-ended cone, contains a rectangular aperture to limit the primary beam to the proper

dimensions at the open end of the cone. The cone should be rectangular in cross section and should be made of transparent plastic.

The cone and the second diaphragm should be constructed so that they can be rotated as a unit through 90 degrees. In this way the greater dimension of the beam can be oriented horizontally for the posterior bitewing and periapical examinations and vertically for the periapical examination of anterior teeth.

A factor that has been neglected in the design of present dental x-ray equipment is the problem of cleanliness. At present, contaminated fingers are used to turn serrated knobs to adjust the timer and other controls. In addition, the trigger switch for the timer is handled in making the exposure. The yoke which supports the x-ray head is also handled repeatedly.

In the future, the problem of contamination may be reduced by suitable changes in the design of the x-ray equipment. It may be possible to protect the parts of the yoke that are handled with a disposable covering. Also, a greater utilization of push buttons may be made in the design of the controls of x-ray equipment. The timer controls may consist of four buttons labeled 1.0, 0.5, 0.1, and 0.05 seconds. The correct time for exposure would be set by depressing, with an uncontaminated little finger, the correct buttons for the proper number of times to total the desired interval of time. The exposure would be initiated by pressure on a footswitch. The entire x-ray apparatus may be redesigned so that it can be cleaned easily.

SUMMARY

It is possible that dental x-ray equipment of the future will be designed to be safer, cleaner, and less cumbersome and to produce roentgenograms that will display superior definition and less enlargement.

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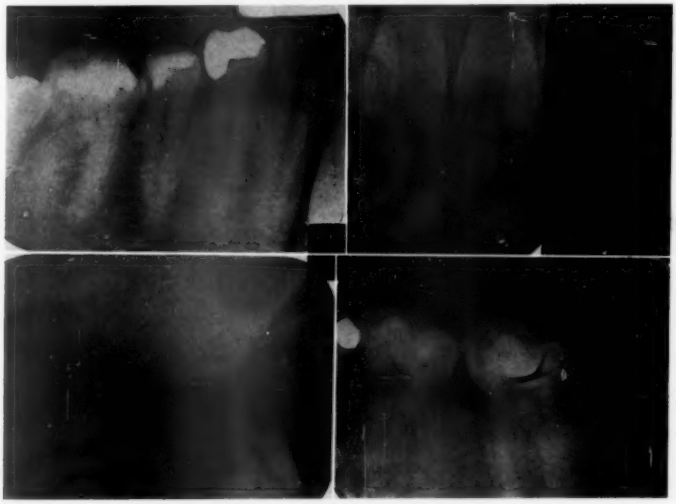
ROENTGENO-QUESTIONS

I am enclosing four x-rays (see print below) which show varying types of black markings on the films. Can you tell me exactly what causes such linear formations and what sort of phenomenon takes place in the emulsion to produce such characteristics?

Dark lines on processed roentgenograms are usually the result of some latent image formation before the film was processed. Since the latent image is normally produced by ionization of the silver bromide crystals in the emulsion, anything that will produce this ionization will produce a latent image. When the film is processed, this latent image will thus appear as a dark line or area on the film.



The American Academy of Oral Roentgenology solicits from the readers of ORAL SURGERY, ORAL MEDICINE AND ORAL PATHOLOGY any questions which deal with technical or interpretive aspects of oral roentgenology. These questions should be sent directly to the editor of this section, Dr. Arthur H. Wuehrmann, School of Dentistry, University of Alabama Medical Center, Birmingham, Alabama; the editor will distribute them for reply to a suitable group within the Academy. Questions, with the answers, will be published at as early a date as possible in "Roentgeno-Questions." Questions, especially those of an interpretive nature, should ordinarily be accompanied by good-quality roentgenograms and a pertinent history. The names of the questioner and the respondent will not be published.

The roentgenogram in the upper left-hand corner shows a dark line mesial to the cuspid tooth. This is commonly seen and is due to the bending of the film by the operator in attempting to place it in the patient's mouth. The energy applied to the film where it was creased produced a latent image which, when the film was processed, resulted in this dark line on the roentgenogram.

The upper right-hand film shows dark lines resulting from static electricity which will often be produced on the surface of the film when it is removed from the film package with excessive force. This is often the case when the darkroom operator attempts to strip films too rapidly. An electric discharge produced these lightning-like streaks upon the surface of the film.

The lower left-hand film is also a result of static electricity being produced in the opening of a film package, but this appears to have been caused by the film package sticking to the enclosed film. This can occur if the film is opened with wet hands or if the film received excessive moisture in the patient's mouth.

The lower right-hand film shows a dark line that is commonly caused by darkroom operators who use their fingernails to grasp the film when removing it from the film package. The resultant mechanical pressure on the emulsion produces a latent image resulting in this line on the processed roentgenogram.

ROENTGENO-ODDITIES

Familial Internal Resorption

The discovery of internal resorption occurring in a tooth is usually made through routine roentgenographic surveys. This replacement by pulpal soft tissue of an area in the dentine surrounding the pulp usually takes place without any clinical symptoms. Patients are more often than not surprised to hear that such a condition exists in one or more of their teeth. The roentgenograms presented here show internal resorption occurring in a permanent tooth of a young woman and in two deciduous molars of her 9-year-old daughter. Neither of these patients was aware of this condition, and clinical examinations failed

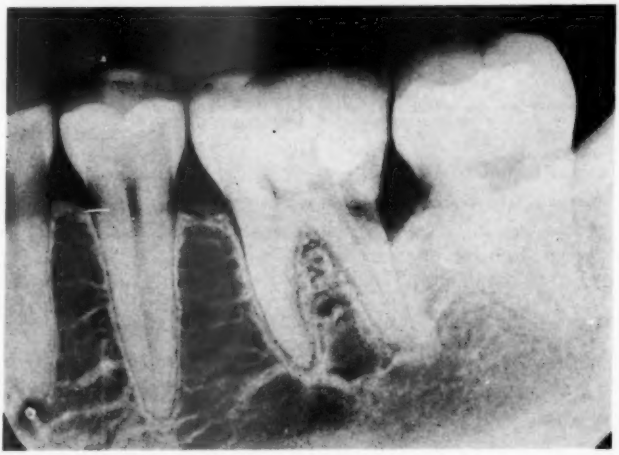


Fig. 1.—Internal resorption occurring in the distal wall of the pulp chamber of the mandibular first molar of a young woman.

Each month this section will bring to the readers of ORAL SURGERY, ORAL MEDICINE AND ORAL PATHOLOGY one or more roentgenograms which demonstrate unusual, unexpected, rare, or bizarre roentgenographic changes. These roentgenograms will be accompanied by an explanation or by words of inquiry, regarding the particular change. All films used in this section will be accepted with the understanding that 2 by 2 or 3¼ by 4 inch slides or glossy photographs of the films will be made available to interested readers through the editor of the American Academy of Oral Roentgenology at the individual's expense. The cost will involve only the photographer's charges. Each slide or print will give credit to the donor. Interesting roentgenograms are solicited from all sources. Please be certain to identify your films properly so that they can be returned. All material for publication should be submitted to Dr. Arthur H. Wuehrmann, University of Alabama School of Dentistry, Medical Center, Birmingham, Alabama.

to reveal any connection between these roentgenolucent areas as seen on the roentgenograms and the oral cavity. In the mother's case the roentgenolucent area on the roentgenogram can easily be mistaken for a carious lesion. Extension of this process through the remaining dentine into the oral cavity could easily result in a pulpitis and periapical inflammation. Clinically, the dentist

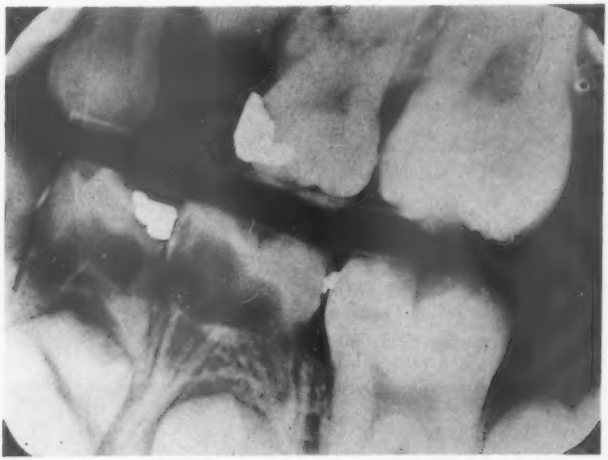


Fig. 2.—Internal resorption occurring in the mandibular deciduous molars of the daughter of the woman whose teeth are shown in Fig. 1.

seeing such an inflamed tooth would very likely be unable to demonstrate the connection between the pulp and the oral cavity. In the daughter's case the resorptive process has progressed to such an extent that it clearly predisposes the involved teeth to pathologic fractures in the region of the necks of the teeth. These roentgenograms demonstrate once again the need for making routine complete-mouth roentgenographic surveys.

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ORAL PATHOLOGY

NEUROGENIC FIBROSARCOMA IN THE MANDIBLE OBSERVED ABOUT ONE MONTH AFTER EXTRACTION OF A LOWER THIRD MOLAR

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THOMA[1] has cited a case of neurogenic fibrosarcoma which appeared in the extraction wound as "proud flesh" a few days after the extraction of a loose tooth. Pathologic examination of the resected jaw revealed that the new growth was attached to the perineurium. The case reported here had been observed in the region of a lower right third molar about one month after extraction of the tooth.

CASE REPORT

A female patient, 23 years of age, was seen on Sept. 1, 1958, with a mass of tissue distal to the lower right second molar (Fig. 1). The mass measured about 2 cm. bucco-lingually and 2.5 cm. mesiodistally, and it had been present for three months. Upon occlusion, the mass touched the maxillary tuberosity. It was hard, with a pedunculated base, and could be moved only slightly with accompanying pain. A roentgenogram of the region distal to the second molar is shown in Fig 2.

The right lower third molar had been extracted on May 29, 1958, but the reason for the extraction could not be ascertained. About a month later, the patient began to experience pain in the region where the tooth had been extracted. She consulted her dentist and, for reasons which we were also unable to ascertain, one of her upper molars was extracted. The extraction did not give her any relief, as the pain persisted. It was at about this time that the patient noticed a growing mass of tissue distal to the lower right second molar.

In view of the lack of definite information concerning the reason or reasons for the removal of the lower third molar and, later, of one of the upper molars, a tentative diagnosis of "epulis granulomatosa" was made. We entertained the suspicion that, somehow, the two extracted teeth might have caused some irritation of the soft tissue in the region of the lower right third molar. The new growth was surgically removed and sections of the specimen were made for microscopic examination.

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Microscopic Findings.—In Fig. 3 a portion of the tumor shows, in low magnification, interlacing bundles of tumor cells; some of them are cut longitudinally, and others are cut transversely. The highly cellular character of the tumor is noteworthy. Under high magnification (Fig 4), the cells appear to be spindle-shaped with wavy nuclei. In some areas, the cells have a tendency toward pleomorphism. Mitotic figures are scattered here and there.

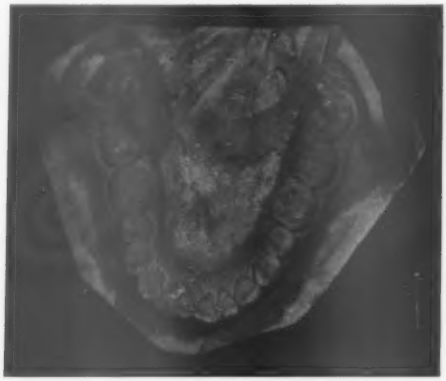


Fig. 1.—Cast of mandible. Note the site and size of the tumor, which is surrounded by arrows.

Fig. 5, *A* shows nerve bundles close to the epithelial pegs of the oral mucosa. Fig. 5, *B* shows a higher magnification of one of the nerve bundles, evidently in contact with a portion of an epithelial peg. The location of a large-sized nerve bundle close to the oral epithelium is not a normal condition. Fig. 6, *A* shows another nerve bundle cut transversely and located close to the oral epithelium. The nerve fibers appear to be undergoing some form of degeneration, but the connective tissue of the perineurium is showing active proliferation.

Fig. 2.—Roentgenogram of region distal to the lower right third molar. There is no definite bone change. The roentgenolucent area appears to be a portion of the still incompletely healed alveolus. Note the apical portion of the alveolus undergoing calcification.

Fig. 6, *B* shows a higher magnification of a portion of the nerve fibers and the proliferative perineurium. Fig. 7, another high magnification of a nerve bundle, shows the nerve fibers undergoing degenerative changes. Some of the axis cylinders are still distinct with their surrounding myelin sheaths. The diagnosis was neurogenic fibrosarcoma.

COMMENT

Fibrosarcoma in the oral region is considered rare.[2] It may arise from the periosteum or from the periodontal membrane. Neurogenic fibrosarcoma in the jaw is likewise considered rare. It may occur as a central or a peripheral new

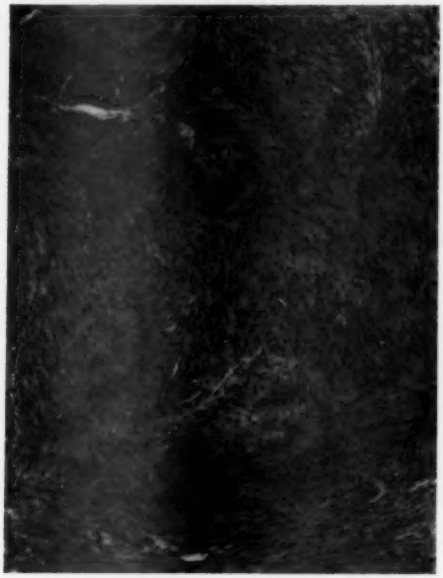
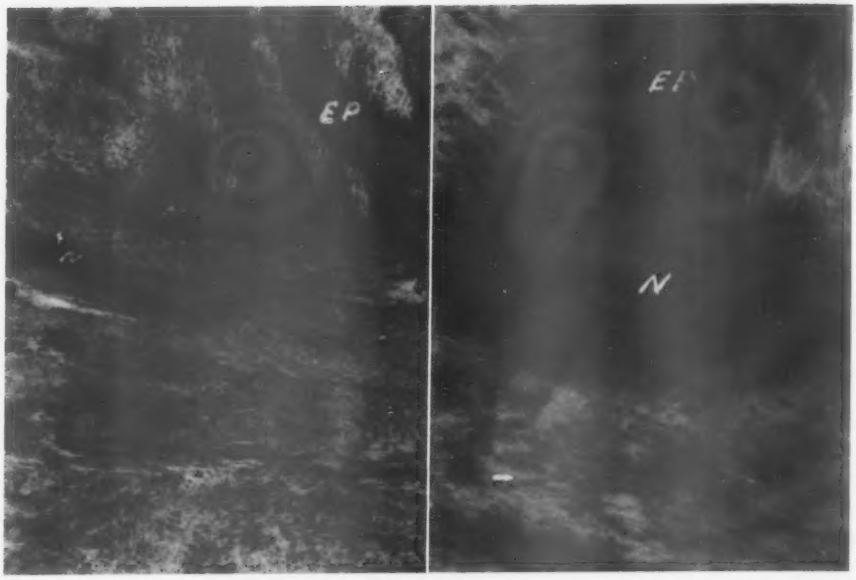


Fig. 3.—Low magnification of a certain area of the tumor mass. Note the highly cellular character of the tumor and the interlacing bundles of the tumor cells. (Magnification, approximately ×120.)

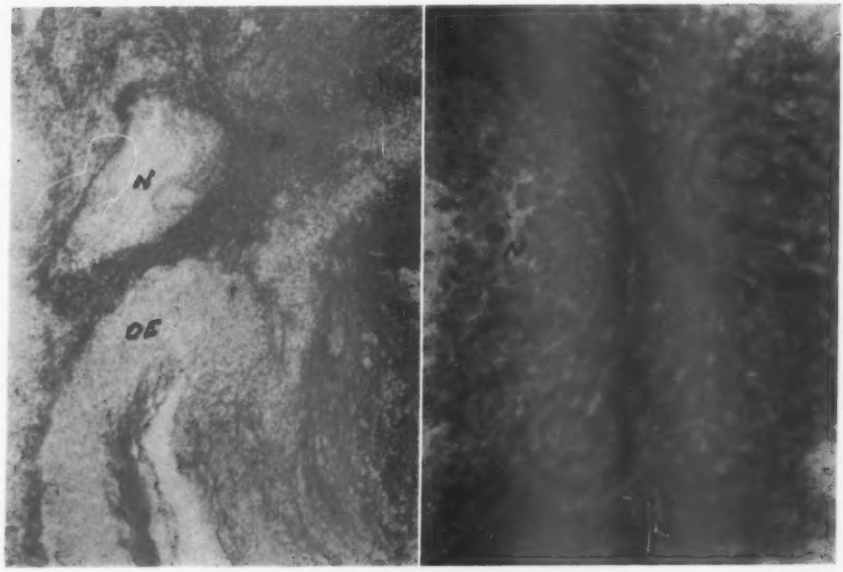
Fig. 4.—Higher magnification of a certain area showing mitotic figures, indicated by arrows, and the tendency of the tumor cells toward pleomorphism in portions marked *A* and *B*. Note the wavy character of the nuclei. (Magnification, approximately ×500.)



A. *B.*

Fig. 5.—*A*, Low magnification of a certain area near the oral epithelium. Note the epithelial pegs (*EP*) and the nerve bundles (*N*). (Magnification, approximately ×120.)

B, Higher magnification of one nerve bundle close to an epithelial peg. Note the size of the nerve bundle in this particular region. (Magnification, approximately ×500.)



A. *B.*

Fig. 6.—*A*, Low magnification of a certain area near the oral epithelium (*OE*) showing a nerve bundle (*N*) cut transversely. Note the proliferation of the connective tissue of the perineurium (*P*). Some of the connective tissue fibers are distributed to the base of the epithelium. (Magnification, approximately ×120.)

B, Higher magnification of a portion of the nerve (*N*) and the proliferative perineurium (*P*). Note the nerve fibers undergoing degenerative changes. (Magnification, approximately ×500.)

growth, and it arises from the perineural connective tissue. The present case appears to be a peripheral new growth, as shown in the roentgenogram (Fig. 2). The roentgenolucent area present appears to be a portion of the alveolus which has not completely healed. It may be noticed that the apical portion of the alveolus is already undergoing bony repair. From the history of the case, as well as from the microscopic findings, there is reason to believe that this is a

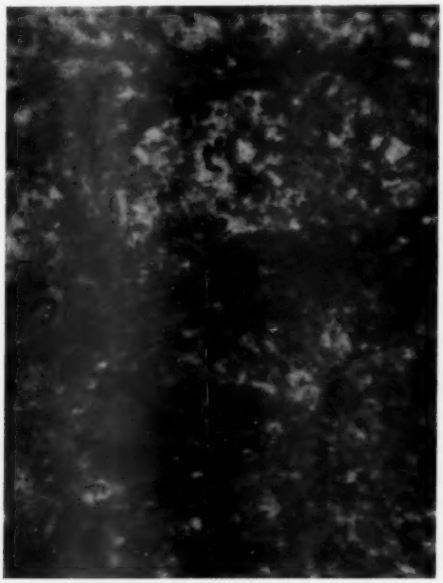


Fig. 7.—Higher magnification of another area showing the nerve fibers undergoing degenerative changes. The axis cylinders and the myelin sheath of some nerve fibers are still distinctly discernible. (Magnification, approximately ×500.)

case of neurogenic fibrosarcoma. First, there was a history of trauma of the nerve, incident to extraction of the tooth, which is believed by some investigators to be one of the etiological factors. Second, the growth was relatively rapid and accompanied by persistent pain, which is also a clinical characteristic of nerve disturbances. Third, the histologic findings show malignancy as evidenced by the highly cellular structure of the mass, the tendency of the tumor cells toward pleomorphism, and the presence of several mitotic figures. The histologic picture resembles that of spindle-cell sarcoma with wavy nuclei. Fourth, the tumor evidently is derived from the perineurium.

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ENDODONTICS

The American Association of Endodontists

Captain Warren J. Hedman, Editor

EFFECTS OF ENDODONTIC TREATMENTS ON PERMEABILITY OF ROOT DENTINE

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INTRODUCTION

THE permeability of the dentine, and the effects of various medicaments on the dentine's permeability have been subjects of interest for some time. However, almost all of this literature relates to the permeability (and density) of the coronal dentine, primarily to the dentine under such lesions as dental caries and dental erosion[1] or to the dentine under cavity preparations.[2, 3] Little has been written concerning the permeability of the dentine in the root or the effect of various endodontic medicaments on this permeability.

The question of root dentine permeability is of interest to endodontists since these tubules may harbor bacteria as a consequence of pulp infection. Sterilization of these tubules is therefore a prime objective in endodontic treatment.[4] To accomplish this, the tubules must be entered by the sterilizing agent. Furthermore, when the canal and the adjacent dentinal tubules have been sterilized, it might be desirable to seal the tubules of the dentinal walls against the possibility of reinfection before the canal is obturated. A number of medicaments have been suggested for this purpose. Prominent among these is silver nitrate.[5] The question as to whether endodontic treatments prior to filling the canal open or close these tubules therefore becomes important.

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This article is part of a thesis submitted by Dr. Marshall in partial fulfillment of the requirements for the degree of Master of Science in the Graduate College, University of Illinois.

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The basic question asked in this study was: How do the various procedures and medicaments used by the endodontist prior to root canal filling affect the permeability of these dentinal tubules? Do the medicaments actually seal or open these tubules?

REVIEW OF THE LITERATURE

Dye Studies.—The permeability of dentine has been studied with the use of dyes and, more recently, isotopes. The work by Fish[6] on the permeability of dentine, published in 1933, is still a classic in this field. Fish placed methylene blue dye into the pulp chamber of extracted teeth for twenty-four hours at 37° C. Ground sections showed that the stain penetrated from the pulp to the dentinoenamel and dentinocemental junction. In older teeth, the peripheral dentine in the root was sometimes hypercalcified and impermeable to the dye. The peripheral ends of these tubules seemed to be occluded by a highly translucent deposit. Fish thought that this translucent area appeared only in cases where periodontal infection was present.

Radioisotope Studies.—More recently Amler and Bevelander[2] investigated the effects of various agents on dentine permeability, using radioactive phosphate (P^{32}) as the tracer. They prepared 210 cavities in canine and molar teeth of dogs. The cavities were then treated with various medicaments (silver nitrate solution, fluorine 2 per cent, alcohol 70 per cent, phenol 10 per cent in alcohol, "zinc oxyphosphate cement," and cavity varnish) or untreated as controls and sealed with silver amalgam. The radioisotope $P^{32}O_4$ (60 μc per cavity) was placed into the cavities after removal of the fillings, at seven days, at fourteen days, or at seventy days, after which the cavities again were sealed. After a suitable interval, the animals were sacrificed and thin ground sections were made through the cavity. Radioautograms were then prepared and analyzed.

The results showed that certain medicaments (alcohol, silver nitrate, phenol cavity varnish), *increased* the dentine permeability. A 2 per cent sodium fluoride increased the permeability initially, but after fourteen days the permeability decreased. However, the unmedicated control teeth also showed a progressive *increase in* permeability. This study was duplicated at the same time by Martin,[3] who used human teeth. His findings substantiated those of Amler and Bevelander.[2] Martin found that zinc phosphate cement and a precipitated layer of calcium fluoride were the only substances which rendered the dentine impermeable to P^{32}.

Radioisotopes are finding an increased usefulness in dental research.[7]

Wach and colleagues,[8] while studying the permeability of dentine and pulp to S^{35}-labeled penicillin in fourteen extracted human teeth, noted that the dentine had a varied permeability. They particularly noted that the uptake of S^{35} was much less or even absent in the apical "transparent" dentine. They did not find any penetration of the labeled penicillin into the intact enamel or cementum. In "a few" histologic sections they described the apical areas of dentine as "transparent dentine."

MATERIALS AND METHODS

In this study we used 253 extracted, single-rooted human teeth. The teeth were stored in normal saline at 44° F. (7° C.). The majority of these teeth were used within three to four days after extraction. To facilitate the mechanical treatment of the canals, the crowns were removed by band saw. The teeth were kept moist at all times.

Permeability of the root dentine was tested before and after a variety of "treatments" by inserting 0.03 ml. of an isotope solution into the canal for twenty-four hours at 37° C. and 100 per cent humidity, then sectioning the teeth and preparing autograms for the analysis of the depth of penetration of the isotope.

Root Canal Treatments.—

Group 1. Untreated controls (pulp removed only): These teeth were treated only by removing the pulp tissue in the canal with a barbed broach. The canals were not subjected to reaming or medication. The apices were sealed with red sticky wax, and the isotope was placed into the canal. This group served as a control to measure the effects of mechanical treatment (reaming and filing) on the permeability of the dentine.

Group 2. Canals treated mechanically but not medicated: In this group, the root canals were enlarged by typical clinical procedures. Kerr reamers and files were used alternately to enlarge the canals from size 1 to size 6. Tap water was used for lubrication and flushing. Enlargement was considered to be complete when a size 6 Kerr file passed freely through the apical foramen. The apices were then sealed with red sticky wax to contain the radioisotope solution, which was then placed into the canal.

Group 3. Canals prepared mechanically and treated with endodontic medicaments: Chemicals and drugs commonly used in endodontics to débride and cleanse the canal prior to obturation were placed into the canals for a stipulated period of time after the canals had been enlarged and prepared as for Group 2. The medicament was then removed and the canal was dried with paper points. The isotope tracer was then placed in the dry canal, and the teeth were stored, as before, for twenty-four hours at 37° C. in a moist chamber. The following medicaments were used:

1. EDTA solution (the disodium salt of ethylenediamine tetraacetate, after Östby[9]) was instilled in the canal for five minutes only.
2. Hydrogen peroxide solution 3 per cent and sodium hypochlorite solution 5.25 per cent were used alternately in 3 c.c. quantities to irrigate the canal continuously for a total of five minutes.
3. Howe's ammoniacal silver nitrate solution and formalin (Condit). The silver nitrate solution was applied for one minute and removed with paper points, and the formalin was applied for one minute.
4. Concentrated sulfuric acid (C.P.) and saturated sodium bicarbonate solution (10 per cent). The acid was placed into the canal

for one minute, after which the root canal was irrigated with the bicarbonate solution until the acid was neutralized as evidenced by cessation of bubbling.

Group 4. Canals prepared mechanically and treated with single medicaments: This group was treated in a manner similar to Group 3 but *single* elements of the endodontic treatments were placed into the canals to determine which element of each treatment was responsible for changes in dentine permeability. The following medicaments were used:

1. Hydrogen peroxide solution 3 per cent, in 3.0 c.c. quantities, for five minutes.
2. Sodium hypochlorite solution, 5.25 per cent in 3.0 c.c. quantities, for five minutes.
3. Howe's ammoniacal silver nitrate solution (Condit) was applied for one minute. The excess was removed by paper points without reduction.
4. Formalin solution (Condit) was applied for one minute. The excess was removed by paper points.
5. Concentrated sulfuric acid (C.P.) was applied for one minute. The excess was then removed with paper points, without neutralization.
6. Sodium bicarbonate (saturated solution) was applied for one minute, after which it was removed with paper points.
7. Eugenol was placed for five minutes and then removed with dry paper points.

TABLE I. RADIOISOTOPES USED IN THIS STUDY

SYMBOL	COMPOUND	HALF-LIFE	RADIATION	IONIC CHARGE	MEV.
I^{131}	Na I (isotonic)	8 days	Beta (-)	-	0.605
Na^{22}	$Na^{22}Cl$	2.6 years	Beta (+) Gamma	-	0.58
S^{35}	$Na_2S^{35}O_4$	87 days	Beta (-)	--	0.167
P^{32}	$Na_3P^{32}O_4$	14 days	Beta (-)	---	1.71

Isotopes Used.—The radioisotope tracer solution was placed into the root canal immediately after the treatment solution was removed from the canal by paper points. Approximately 0.03 c.c. of solution was placed into each canal. The radioisotope solutions were adjusted to contain 100 μc per cubic centimeter or 3 μc of radioactivity per tooth. S^{35} as sodium sulfate, Na^{22} as sodium chloride, I^{131} as sodium iodide, and P^{32} as sodium phosphate were the tracers used (Table I). These isotopes were selected to test the influence of ionic charge, valency, molecular size, and chemical reactivity on the penetrability through the dentine as well as the effects of the different medicaments on the penetration of different ions. After the isotope was placed into the canal from a plastic disposable syringe, the teeth were stored for twenty-four hours in a closed chamber at 37° C. and 100 per cent humidity.

Method of Radioautography.—After twenty-four hours' storage, the teeth were sectioned longitudinally, according to the technique described by Going,[10]

to give two hemisections. The flat surfaces were sanded lightly and washed to remove impacted contaminants caused by cutting; then they were dried.

Autograms were prepared from each hemisection, using Minimax extra-fast, double-emulsion, dental x-ray film. The flat side of the hemisection was placed in tight contact with a single film by means of a plastic clamp, as described by Going.[10] Exposure time was determined empirically for each isotope to give the greatest degree of definition. The "average" exposure time for these survey autograms was twenty-four hours. At least one underexposed and one overexposed autogram were also produced to locate the isotope penetration more exactly. Roentgenograms were made of each hemisection with an ordinary x-ray machine to outline the tooth. The roentgenograms were superimposed on the autograms, and the composite picture was printed to permit more accurate location of the isotope within the tooth.

Autograms prepared from hemisections are much less sharply defined and contain a great deal more halation than autograms prepared from thin ground sections, for the beta emissions from isotope contained in the dentine below the cut surface also affect the film.[11] In this study, however, thin sections were not possible since the root canal filling was lost and the two halves of the section became separated.

Method of Analysis.—The permeability of the dentine to the radioisotopes was evaluated from the autograms. Fig. 1 shows the method used to assess the dentine permeability by the depth and extent of isotope penetration. A dentine permeability index (DPI) was computed for each specimen in each of three root areas on the basis of the depth and extent of isotope penetration, as follows:

The root was divided into thirds—cervical, middle, and apical (Fig. 1). Each area (cervical, midroot, and apical) was then further subdivided into thirds to designate *depth* of penetration and *extent* of penetration. *Depth* of penetration was quantitated by dividing each area into thirds along the length of the dentinal tubules from the canal wall to the cementum (Fig. 1). Penetration to one-third, two-thirds, or through the entire length of the dentinal tubules was then recorded as 1, 2, or 3. *Extent* of penetration was evaluated by dividing each area along the length of the root canal into thirds (Fig. 1). If the tubules penetrated by the isotope extended over one-third, two-thirds, or the entire length of the area, the extent was recorded as 1, 2, or 3. Thus, each root area (cervical, middle, or apical) was divided into nine squares. A dentine permeability index (DPI) was determined for each root area by multiplying the average depth by the average extent of isotope penetration in that area. The same result was achieved by counting the number of squares involved in the area (maximum, 9) (Fig. 1).

FINDINGS

Permeability of Untreated Root Dentine (Pulp Removed Only).—The permeability of root dentine varied in different root areas. The cervical dentine was most permeable. The average DPI to S^{35} was 7.4 (Fig. 2). The midroot

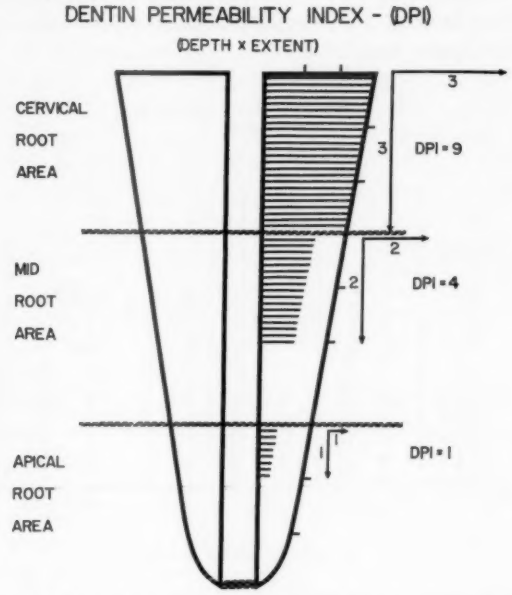

Fig. 1.—Schematic drawing showing method of assessing penetration of isotopes into dentinal tubules. The dentine permeability index (DPI) for each third of the root was calculated by multiplying the depth of penetration into the tubules (1, 2, or 3) by the extent of root surface entered along the canal (1, 2, or 3).

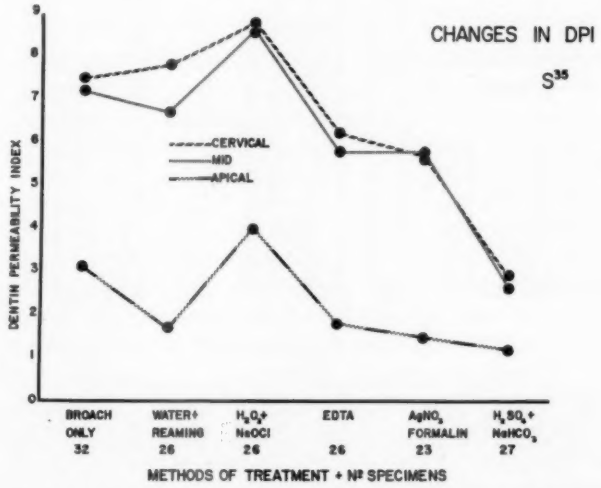

Fig. 2.—Graph showing changes in average dentine permeability index (DPI) to S^{35} in cervical, midroot, and apical dentine after various root canal treatments. Note decreased permeability of apical dentine.

area showed an average DPI of 7.2, but most specimens showed a DPI of 9 (Fig. 3). This area of root dentine was therefore only very slightly less permeable than the cervical area.

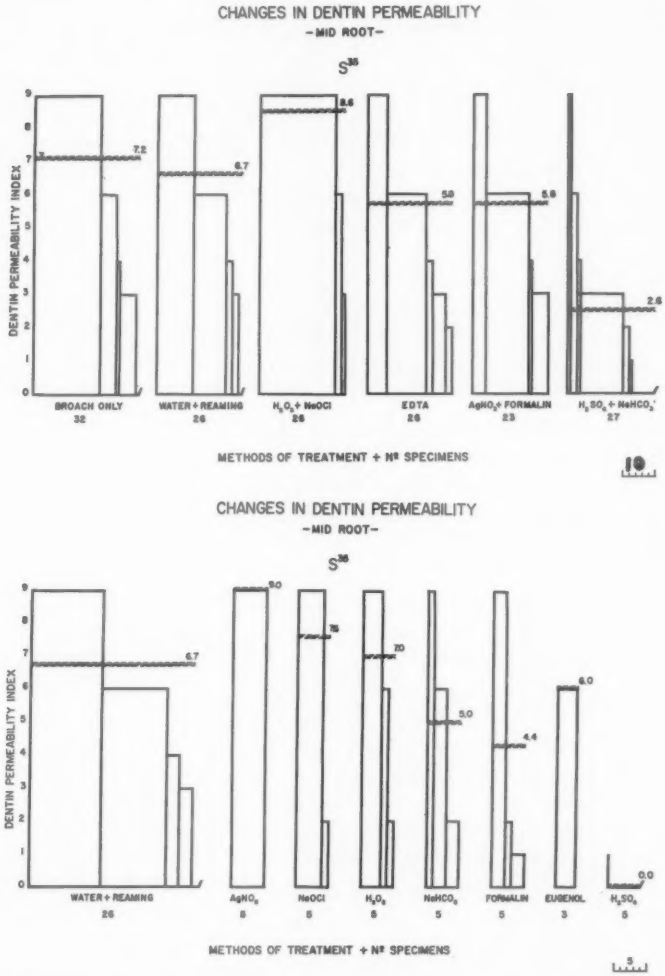

Fig. 3.—Histograms showing changes in permeability of midroot dentine to S^{35} after various root canal treatments. The average dentine permeability index (DPI) per treatment group is shown by the striped line. The scales in the lower right-hand corner signify number of specimens. The bottom histograms indicate changes after treatment with single medicaments.

The striking finding was that the apical area of dentine seemed to be impermeable to all isotopes. Fig. 2 shows the greatly reduced permeability of this area to $S.^{35}$ Most specimens had a DPI of 0.

The impermeability of the apical dentine was also clearly shown by dyes. Freshly extracted teeth immersed in 0.025 per cent gentian violet dye showed with striking clarity a penetration of the dye into all areas of the dentine in the crown and in the root but no penetration at all in the apical area of the dentine. In general, this area was covered by a thick layer of secondary cementum. There seemed to be a relationship between the area of apical dentine which was impenetrable to dye and isotope and its covering by secondary cementum. However, this aspect of the problem will be investigated separately.

Effect of Mechanical Treatment on Dentine Permeability.—The permeability of the root dentine in all areas was generally slightly reduced by enlarging the canal and irrigating it with tap water (mechanical reaming). However, this reduction in dentine permeability was not statistically (or clinically) significant.

Fig. 2 shows that the midroot dentine was less permeable to S^{35} after mechanical treatment, the DPI decreasing from 7.2 to 6.7. The dentine was also less permeable to Na^{22} and I^{131} after reaming (Fig. 4). Only P^{32} sometimes penetrated the midroot dentine more deeply after this treatment (Fig. 4).

Although the apical root dentine area was almost impermeable before mechanical treatment, reaming reduced the permeability to $Na,^{22}$ $I,^{131}$ and S^{35} even more (Figs. 2, 3, and 4).

With minor exceptions, therefore, the permeability of the root dentine to isotopes was *reduced* by mechanical preparation of the root canal. This reduction was not great, however, and it probably was insignificant from a clinical point of view.

Effects of Endodontic Medicaments on Dentine Permeability.—

Sulfuric acid and bicarbonate of soda solutions: The most striking change in dentine permeability was observed after the use of sulfuric acid alone and after neutralization by bicarbonate of soda. Sulfuric acid alone applied for one minute produced absolute blockage of the dentinal tubules to penetration by $S.^{35}$ All root areas showed a DPI of 0 (Fig. 3). Specimens treated with both solutions showed a marked *decrease* in the permeability of the dentine to S^{35} to less than one-third the original DPI values (Figs. 2, 3, and 5, *C*). Treatment with bicarbonate of soda solution alone for five minutes resulted in a significant but lesser decrease in permeability of the midroot dentine to S^{35} (DPI, 5.0) (Fig. 3). It was therefore concluded that the marked decrease in dentine permeability was primarily due to the action of the sulfuric acid.

The dentine behaved erratically to penetration by $Na,^{22}$ $P,^{32}$ and I^{131} after the same treatment (Fig. 4). Although the permeability to I^{131} was decreased in the cervical and midroot areas, the permeability of the apical dentine was increased (Fig. 4). Permeability to P^{32} and Na^{22} was *increased* slightly in all areas (Fig. 4).

Hydrogen peroxide and sodium hypochlorite solutions: Specimens treated alternately with peroxide and hypochlorite solutions showed a significant

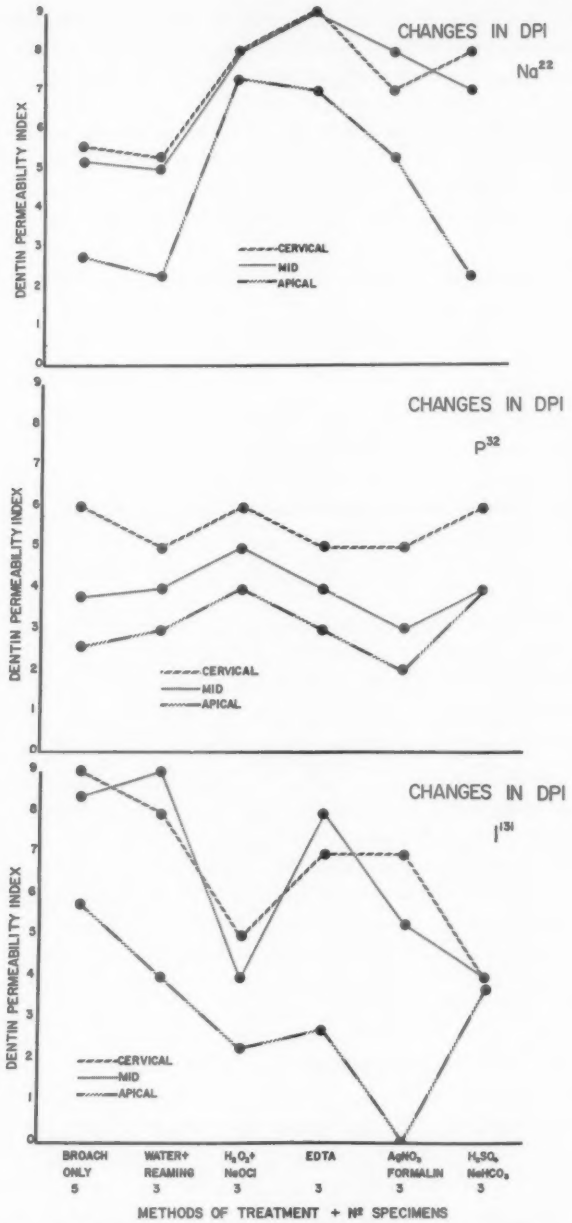

Fig. 4.—Graphs showing changes in dentine permeability (as average DPI) to Na^{22}, P^{32}, and I^{131} after various root canal treatments.

increase in permeability to S^{35} in all three root areas, even the apical area (Figs. 2, 3, and 5, *B*).

This treatment also increased the dentine permeability to Na^{22} and to P^{32} (Fig. 4) as well as to S.[35] Interestingly, the permeability to I^{131} was strikingly *reduced* by this treatment (Fig. 4). This suggests some chemical reaction between the I^{131} and the chloride ions released from the hypochlorite solutions.

It was interesting to note that when hydrogen peroxide and sodium hypochlorite solutions were applied alone for five minutes, each produced only a slight increase in dentine permeability (Fig. 3). This was in contrast to the marked increase in permeability produced by the combined treatment. In other words, the effect of the combination exceeded that of either treatment alone and was more than simply additive. (Compare Fig. 3, top and bottom.)

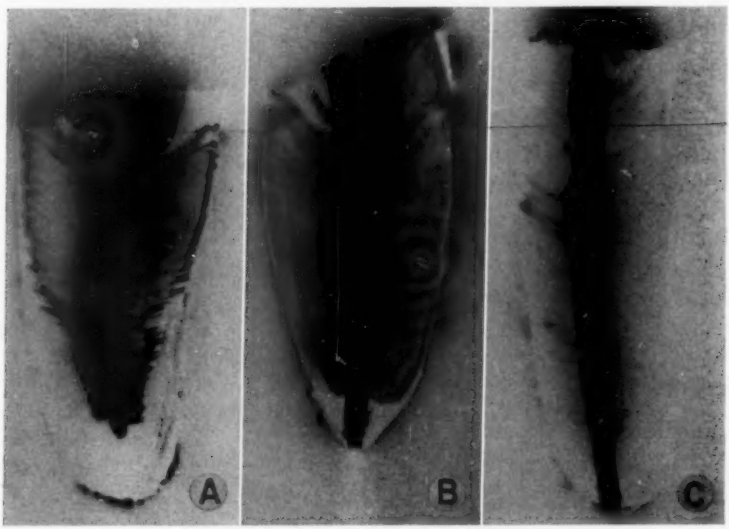

Fig. 5.—Illustrations showing penetration of S^{35} into the root dentine of incisors after various root canal treatments. *A*, Autogram of control specimen (pulp removed only, no treatment). No e concentration of isotope just inside the dentinocemental junction. *B*, Autogram of canal enlarged mechanically by reaming and treated with solutions of hydrogen peroxide and sodium hypochlorite. Note the increased penetration of S^{35} into the dentine. *C* Tooth treated with solutions of sulfuric acid and bicarbonate of soda, showing marked reduction of dentine penetration by S^{35}.

Ammoniacal silver nitrate and formalin solutions: Silver nitrate solutions have been used for a long time to block the dentinal tubules and decrease their permeability.[5] In this study, specimens treated with ammoniacal silver nitrate (one minute) and formalin (one minute) showed a small but significant reduction in dentine permeability to S^{35} (Figs. 2 and 3).

Replicate series (three teeth each) of the same treatment using different isotopes showed a marked reduction in permeability to I^{131} (Fig. 4, bottom).

The permeability of the apical dentine to I^{131} was dramatically reduced to 0. The permeability to P^{32} was not markedly changed (Fig. 4, middle). However, the permeability to Na^{22} was *increased* (Figs. 4, top and 6, *B*).

Silver nitrate alone and formalin alone were then applied for one minute to determine which was the active ingredient in causing the decreased permeability to $S.^{35}$ Surprisingly, when silver nitrate solution was used alone, it produced a striking *increase* in dentine permeability, the greatest increase in the series (Fig. 3, bottom). The midroot DPI increased from 6.7 to 9.0. Formalin alone, on the other hand, showed a significant *decrease* in the midroot permeability to S^{35} (Fig. 3, bottom).

The increased permeability to silver nitrate may be related to the coagulation and shrinking of the odontoblastic processes within the tubules. Formalin, on the other hand, may precipitate protoplasmic proteins and thus block the tubules somewhat. The reduced permeability resulting from the use of both solutions may be the result of the precipitation of silver by the formalin which, in turn, causes a more effective blocking of the tubules. This effect is not marked, however, and seems to be much less than many clinicians would like to think.

Ethylenediamine tetraacetate (EDTA) solution: Dentine treated with EDTA solution for five minutes after mechanical reaming became less permeable to S^{35}. The decrease in permeability was similar to that produced by the action of silver nitrate and formalin. The permeability to S^{35} decreased from an average DPI of 7.8 to 6.2 at the cervical area and from 6.7 to 5.8 at the midroot. The permeability of the apical area was unchanged at a DPI of 1.7 (Fig. 2).

On the other hand, dentine permeability to Na^{22} was *increased* after EDTA treatment, *decreased* to $I,^{131}$ and *not changed* to P^{32} (Fig. 4). The similarity in these results to silver nitrate and formalin treatment is striking.

The use of EDTA increases the speed and ease of mechanical instrumentation by softening the dentine walls.[9] This is accomplished by chelation. The dentine is decalcified by the removal of calcium. While decalcification by acid resulted in a remarkable decrease in the permeability, decalcification by EDTA reduced the permeability only slightly.

Eugenol: The permeability to S^{35} was decreased in all root areas after application of eugenol. The oiliness of the substance probably limited the penetration of the water-soluble isotopes used in this study (Figs. 3 and 6, *D*). The decrease in permeability was similar to that which followed the use of silver nitrate-formalin and EDTA. It is possible that the use of eugenol instead of formalin to reduce the silver nitrate might have achieved a greater decrease in dentine permeability.

Comparison of Different Isotopes.—The changes in dentine permeability that resulted from the various treatments were particularly well defined by S^{35} (Fig. 5, *A*, *B*, and *C*) and far superior to those produced by any of the other isotopes (Fig. 6, *A*, *B*, *C*, and *D*). It must be remembered, however, that these autograms were prepared from hemisections of teeth and not from thin slices. In such a situation the short track and low mev. of the S^{35} showed up to

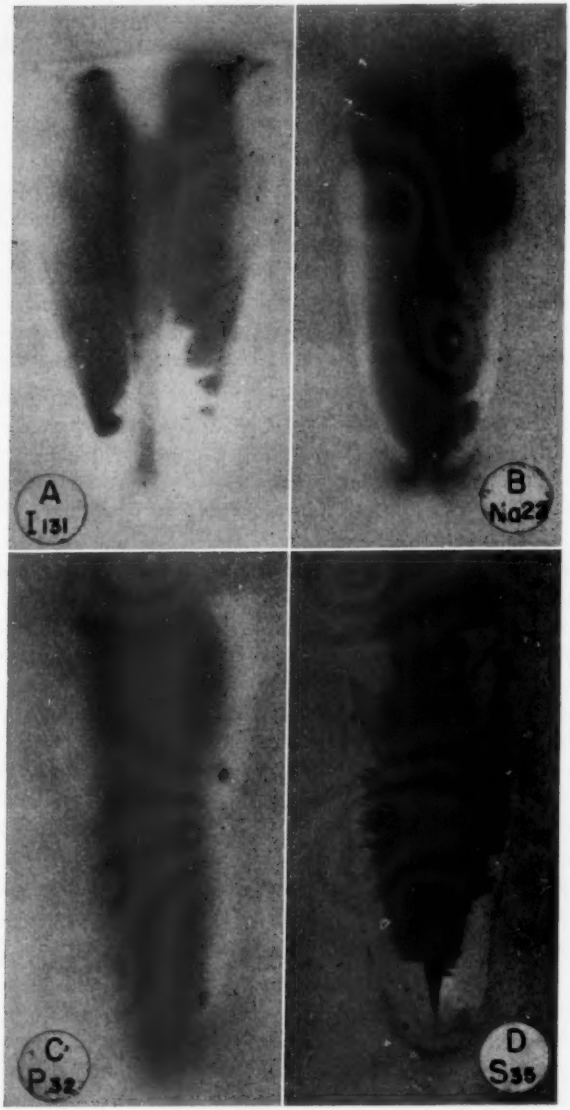

Fig. 6.—Illustrations showing penetration of root dentine after various root canal treatments by I^{131}, Na^{22}, P^{32}, and S^{35}. *A*, Autogram of a control tooth (canal enlarged, reaming only) showing penetration of I^{131}. Note that this isotope penetrates cervical and midroot areas to the dentinocemental junction but does not concentrate there as does S^{35} (Fig. 5). The apical area is impermeable to I^{131}. *B*, Autogram showing dentinal penetration by Na^{22} after application of ammoniacal silver nitrate and formalin. Note that tubular details are obscured. *C*, Tooth treated with sulfuric acid and bicarbonate of soda. Autogram shows failure of P^{32} to penetrate the dentine. Note severe halation. *D*, Incisor canal enlarged by reaming and treated with eugenol. Note reduced penetration of S^{35} and area of impermeable apical dentine.

advantage, since only the isotope in the surface layer of the dentine affected the silver grains in the film.[11] The fuzziness of the autograms taken with P^{32} was undoubtedly caused by radiations coming from deeper layers in the dentine, activating additional silver grains, obscuring the details, and causing also excessive contrast and halation.[12] In thin sections of teeth, all isotopes gave much sharper and better-detailed autograms.[10]

One other variable should be pointed out. The variable results obtained by the use of different isotopes suggest that the chemical nature of the isotope affected its behavior. Isotope penetration is not only a simple diffusion of the ion into the tubular structure of the dentine, but it is affected by the nature of the substances used to treat the dentine. For example, treatment with hydrogen peroxide and sodium hypochlorite rendered the dentine more permeable to all the isotopes except $I,^{131}$ to which the dentine became *less* permeable. Evidently, the two halogens interacted.

The Dentinocemental Junction.—The dentinocemental junction was plainly outlined in many autograms, especially those prepared from S^{35}. When the S^{35} penetrated to the dentinocemental junction, it appeared to accumulate in the area corresponding to Tome's granular layer (Fig. 5, *A* and *B*). The other isotopes did not show this layer.

It is interesting to note that none of the isotopes penetrated beyond the dentinocemental junction, no matter how deeply they went into the tubules. Going[10] demonstrated that isotopes placed outside the tooth penetrated the cementum only to the dentinocemental junction and did not enter the tubules. These findings suggest that the dentinocemental junction (like the dentinoenamel junction) acts as a limiting membrane to the passage of fluids from inside or outside the tooth. Wassermann and associates,[13] however, found no limitation to the penetration of P^{32} through the cementum into the dentine in specimens treated *in vivo*. The difference in our results may be due to our *in vitro* conditions.

These autograms show quite clearly that the pathway of penetration is via the dentinal tubules. Whether or not the isotopes can also diffuse through the calcified dentine matrix could not be determined by these autograms.

DISCUSSION

The permeability or impermeability of the dentine has long been an important question in operative dentistry. Beust[14, 15] and Fish[6] studied the changes in dentine permeability with age and under a variety of lesions, such as caries, erosions, attrition, and abrasions. They showed that the tubules under active lesions tend to be permeable to dyes, while the arrested lesions are not penetrated by dyes. Bodecker and Lefkowitz[16] concluded that maturity, abrasion, or caries greatly reduced dentine permeability.

Sealing of the dentinal tubules after cavity preparation to prevent the penetration of irritants (acid and mercury) from fillings to the pulp has long been recommended. Amler and Bevelander,[2] however, as well as Martin,[8]

showed that many substances used for that purpose, such as phenol, zinc chloride, cavity varnish, phosphate cements, and silver nitrate, actually *increased* the permeability of the dentine to both dyes and isotopes instead of sealing them. Only sodium fluoride solutions showed any tendency to seal these tubules. The actual amount of work done on this subject is rather small, however, in view of its clinical importance.

The permeability of root dentine and the effects of medicaments and root canal treatments on this permeability have been studied even less than the coronal dentine. Wach and associates,[8] Wassermann and his group,[13] and Fish[6] all mentioned areas of impermeable root dentine incidental to other investigations, but they never reported specific studies on the root dentine itself.

Apical Dentine.—The impermeability of the apical dentine to isotopes was a striking finding in this study (Figs. 5, *A* and *B* and 6, *A* and *D*). The apical dentine was only one-half to one-third as permeable as the midroot or cervical dentine (Figs. 2 and 4). This area of dentine was "transparent" when examined by reflected light and was usually covered by secondary cementum. Fish[6] described it as hypercalcified and hyalinized dentine. Further study of this area (including a longitudinal study) should be more revealing.

Effects of Medicaments.—This study showed that only sulfuric acid actually reduced the permeability of the dentine to a clinically significant point. The reduction in permeability caused by mechanical reaming was very slight and inconstant and not at all significant. The reduction in permeability caused by silver nitrate and formalin, EDTA, and eugenol was somewhat greater and somewhat more constant but too small to be of clinical significance. In contrast, the reduction in permeability caused by the sulfuric acid was highly significant and constant.

A significant *increase* in dentine permeability followed the use of peroxide-hypochlorite solutions. The combination was much more effective than either solution used alone.

The interesting finding was the marked *increase* in dentine permeability following the use of silver nitrate solution alone, without reduction. Almost all specimens became completely permeable to S^{35} to the dentinocemental junction. This supports the similar finding in the coronal dentine reported by Martin.[3]

Isotope Tracers.—The erratic results produced by using Na^{22}, P^{32}, and I^{131} as tracers probably indicate that they may be chemically reactive with the dentine or the medicaments. The $P^{32}O_4$ probably reacts with calcium ions of the tooth substance, while Na^{22} and I^{131} react with the chloride ions in the various medicaments. S^{35} as the sulfate produced the most consistent results as well as the best autograms. It is possible that more consistent results could be obtained by using a non-ionizing isotope, such as C^{14}-labeled sucrose or protein.

The results obtained in this study again emphasize that predicting the action of drugs on dentine on a theoretical basis is not safe. Answers can be obtained only by experimentation and accumulation of reliable data.

SUMMARY AND CONCLUSIONS

The purpose of this investigation was to study the changes in dentine permeability to four different isotopes after the dentine in the root was subjected to different endodontic procedures (mechanical reaming and the application of different medicaments). The root canals of 253 freshly extracted single-rooted human teeth were subjected to a variety of endodontic procedures (mechanical reaming, application of sulfuric acid, silver nitrate, hydrogen peroxide and sodium hypochlorite, or EDTA solution) after which one of four radioisotopes (S^{35}, I^{131}, Na^{22}, and P^{32}) were instilled for twenty-four hours. The teeth were then hemisectioned and autograms were prepared.

Analysis of these autograms showed the following:

1. The cervical and midroot dentine areas were very permeable to all the isotopes. However, the apical area of root dentine was highly impermeable to these isotopes. Treatment had comparatively little effect on the apical dentine. The impermeable apical dentine (transparent, sclerosed) was usually that portion covered by secondary cementum. Further studies are indicated to determine the nature and the significance of the impermeable area of apical dentine.

2. Mechanical enlargement of the canal (reaming and filing) had relatively little effect on the permeability of the dentine but did produce a slight decrease.

3. Sulfuric acid markedly *reduced* the permeability of the dentine to isotopes, especially to S^{35}, in all root areas. This was also true when sodium bicarbonate was used to neutralize the acid.

4. Hydrogen peroxide and sodium hypochlorite solutions, used alternately, produced a significant *increase* in dentine permeability to isotopes. Hydrogen peroxide alone and sodium hypochlorite alone also increased dentine permeability, but to a much lesser degree than when the two medicaments were combined.

5. Silver nitrate, used alone, produced a marked *increase* in dentine permeability. This increase was equal to or greater than that produced by hydrogen peroxide and sodium hypochlorite combined. However, silver nitrate neutralized by formalin and formalin alone produced a decrease in dentine permeability, but this decrease was, in general, not significant statistically or clinically.

6. EDTA, eugenol, and sodium bicarbonate solution each produced a slight *decrease* in dentine permeability. However, this decrease was not significant. EDTA produced changes in dentine permeability to different isotopes which were very similar to those produced by silver nitrate-formalin.

7. The dentinocemental junction acted as a barrier to the passage of isotopes from inside the canal outward and from outside the canal inward.

8. Radioisotope tracers proved to be useful and delicate tools for testing dentine permeability. S^{35} was the most efficient tracer used in this study.

Sincere thanks are due Noel D. Martin, Visiting Professor from Sydney, Australia, Dr. E. Kaplan, Associate Director of the Radioisotope Service, and Mr. P. Lund, Head of the Photographic Service of the Veterans Administration Hospital at Hines, Illinois, for their splendid cooperation and helpfulness.

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RESEARCH

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A BOVINE GLAND EXTRACT FOR CALCULUS FORMATION

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THE in vitro formation of synthetic calculus, with pooled human saliva as substrate, has been reported.[1] The method, though successful, requires large volumes of saliva which, in addition to being difficult to obtain, might vary in composition daily. We have therefore attempted to develop a system which could replace human saliva as a substrate in the formation of synthetic calculus.

In saliva, the mucoid is the component mainly responsible for viscosity. If there could be isolated from salivary glands a material which would give a solution this characteristic, the solution could then be fortified with the required amounts of calcium, phosphate, carbonate, and other necessary constituents and used in place of saliva as a substrate for studying calculus formation.

As a source of mucoid we have investigated the bovine submaxillary gland. The glands, obtained fresh, were minced, extracted with water, and lyophilized. This extract, fortified with the necessary inorganic components in a buffered solution, was tested in the dipping apparatus of Leung.[1] The results of this investigation indicate the formation on teeth of a deposit comparable to naturally occurring calculus.

EXPERIMENTAL

Extraction of Submaxillary Gland.—One hundred grams of bovine submaxillary gland, obtained fresh and cleaned from adhering fat and sheath, were minced in a Waring Blendor with 300 ml. of distilled water. The extraction was allowed to proceed, with stirring, for eighteen hours at 5° C. The pH during the extraction remained in the range of 6.9 to 7.1. Following

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extraction, the insoluble material was removed by centrifugation, followed by filtration with the aid of Celite 535 and Hy Flow Filter Cel. The highly viscous crystal-clear solution was lyophilized. By this procedure there was obtained 12.5 grams of a fluffy, light brown powder which was tacky when moist and which gave positive Molisch and biuret tests.

Procedure for Synthetic Calculus Formation.—The procedure for the formation of synthetic calculus was essentially that employed by Leung,[1] except for the solutions employed.

Substrate solutions: The control solution was prepared as follows: 65 ml. water; 70 ml. calcium carbonate (10 mg. per cent calcium); 15 ml. 0.2 M phosphate buffer, pH 7.4; and carbon dioxide bubbled in until a final pH of 6.8 is reached. The solution contained 4.7 mg. per cent calcium[2] and 22.0 mg. per cent phosphate.[3]

The test substrate solution was prepared in the same way as the control solution, except that before adjustment of pH to 6.8 with carbon dioxide the gland extract was added to make a 0.1 per cent solution. The test substrate contained 5.5 mg. per cent calcium and 24.5 mg. per cent phosphate.

Viscosity Determinations.—Relative viscosities were determined with an Ostwald viscosimeter kept at constant temperature by a thermostated water bath.

RESULTS

Table I shows the results of a comparison of the relative viscosities of saliva and gland extract. From the determinations, one can see that a 0.1 per cent solution of the gland extract gives a relative viscosity comparable to that of fresh human saliva. For this reason, a 0.1 per cent solution of the extract was used as a substrate in the synthetic calculus formation. A study of the stability of the dried extract over a period of three months indicated no loss in viscosity characteristics.

TABLE I. RELATIVE VISCOSITIES

SOLUTION	25° C.	37° C.
Water	1.00	1.00
Whole saliva	1.58	1.49
Lyophilized saliva (1%)	1.29	1.31
1.0% Gland extract	7.09	6.86
0.1% Gland extract	1.61	1.70

Preliminary analysis (Table II) of the gland extract and of material partially purified by a chloroform-octanol treatment indicated that both the crude and the purified material gave positive Molisch and biuret tests. The amounts of nitrogen and hexosamine (8.68 per cent and 20.10 per cent,[4] respectively) are in agreement with the results reported by Meyer,[5] that is nitrogen 8 to 9 per cent and hexosamine 18 to 22 per cent for a mucoid obtained

from bovine submaxillary gland by a precipitation method. The total protein, 9.74 per cent,[6] and glucosamine nitrogen do not account for all of the Kjeldahl nitrogen present, indicating another nitrogen-containing compound.

TABLE II. PROPERTIES OF EXTRACT

COMPONENT	CRUDE (per cent)	PURIFIED (per cent)
Ash	13.75	1.90
Calcium (per cent ash)	5.50	-
Phosphate (per cent ash)	25.22	-
Kjeldahl nitrogen	10.20	8.65
Total protein	26.20	9.74
Glucosamine	-	20.10

To further characterize the extract, paper chromatography was employed. Hydrolysis was carried out in a sealed tube with 0.5 N sulfuric acid for thirty minutes to one and one-half hours, and the hydrolysate was chromatographed in a butanol:acetic acid:water system (5:1:4). From the results (Table III), we can see that the hydrolysate contains glucosamine, N-acetylglucosamine, and

TABLE III. CHROMATOGRAPHY OF HYDROLYSATE*

	R_f VALUES	
	STANDARD	HYDROLYSATE
Glucosamine	0.287	0.273
	0.357	0.341
N-acetylglucosamine	0.457	0.450
Glucuronolactone	0.472	0.469
Unidentified		0.183

*Butanol:acetic acid:water (5:1:4).

glucuronic (galacturonic) acid plus another slow-moving component which gives a positive ninhydrin test. If the hydrolysis is continued for longer than one and one-half hours, the N-acetylglucosamine component disappears.

TABLE IV. COMPOSITION OF SYNTHETIC AND CLINICAL CALCULUS

CONSTITUENT	SYNTHETIC CALCULI SUBTRATE		CLINICAL CALCULUS
	SALIVA*	EXTRACT	
Organic	31.6	22.3	12.9-28.4
Inorganic	68.4	77.7	71.6-87.1
Calcium (per cent ash)	37.1	30.5	30.7-39.0
Phosphate (per cent ash)	17.7	17.8	16.8-20.5
Calcium phosphate	2.09	1.71	1.79-2.16

*Values obtained from literature.[1]

For the formation of synthetic calculus, a 0.1 per cent solution of the crude extract was made up in phosphate buffer as described previously. The solutions were replaced daily. The final pH after twenty-four hours in the dipping apparatus was 7.4. The system ran for four weeks, after which time the deposit on the teeth was removed by scaling and analyzed.

The deposit obtained from the control teeth had an average dry weight of 8.51 mg. per tooth, while that from the extract-treated teeth averaged 12.15

mg. per tooth. The deposit on the control teeth is not held very fast and can be removed by rubbing with the finger, but the deposit on the extract-treated teeth must be removed by scaling.

Table IV shows the results of the analysis of the material removed from the extract-treated teeth. The deposit, which is fairly evenly distributed over the teeth, is essentially an inorganic deposit in an organic matrix. The results indicate that the organic content and the calcium phosphate ratio are in agreement with the values reported in the literature.

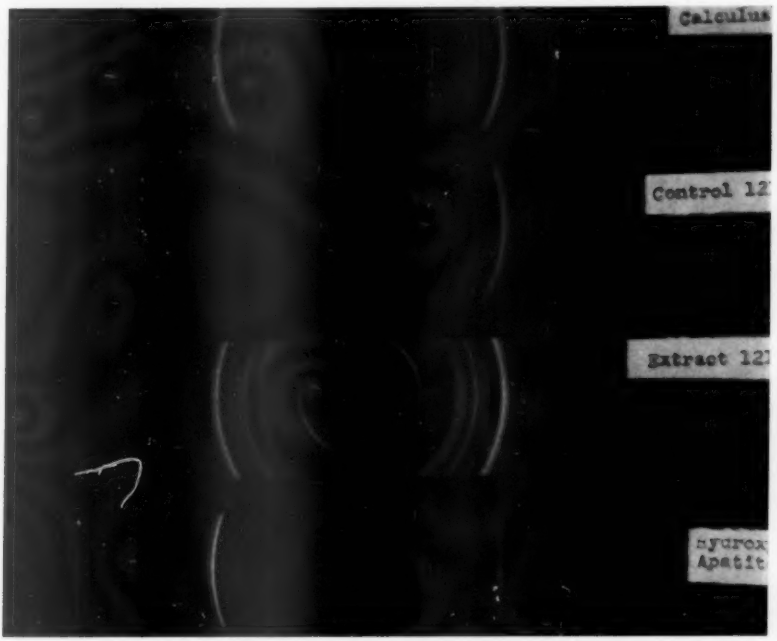

Fig. 1.—X-ray diffraction patterns. (Courtesy of Dr. J. G. Ventolo, Colgate-Palmolive Company, Jersey City, New Jersey.)

A comparative x-ray diffraction analysis (Fig. 1) of the deposit and clinical calculus showed the main constituent of both to be hydroxyapatite.

CONCLUSION

A method for the formation of synthetic calculus by an artificial means with a bovine submaxillary gland extract as substrate is described. Chemical and x-ray analyses show the deposit to be similar to clinical calculus.

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THE EFFECT OF LOCAL ANESTHETICS ON THE RESPIRATION OF DENTAL PULP

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INTRODUCTION

NUMEROUS investigations have been made of the chemistry, physiologic and synergistic actions, toxicity, and clinical administration of local anesthetics.[1] The physiologic action of several anesthetics has been studied to determine their mode of action on tissues or to determine what effect they may have on tissue metabolism. Among the tissues which have been studied are brain,[2-13] liver, [2, 13, 14] kidney,[15] fish muscle,[16] heart muscle,[17] and spinal cord.[18, 19] Anesthetics tested on such tissues have included ether,[2, 4, 6, 18-20] chloroform,[2, 4, 16] chloralosane,[15] urethane,[3] chloral hydrate,[3] Avertin,[3] magnesium ion,[3] divinyl ether,[4] ethylene,[4] cyclopropane,[4] nitrous oxide,[4, 6] ethanol,[3, 4] dihydromorphinone hydrochloride,[4] chlorobutanol,[3, 10, 17] tetracaine,[17] propazone,[17] cocaine,[7, 8, 14, 17] procaine,[14, 17] paraldehyde,[17] xenon,[6] Metycaine,[14] Diothane,[14] Nupercaine,[14] thiopental and phenobarbital,[3, 13] Amytal,[4] pentobarbital,[17] and Pentothal sodium.[9, 12] Fisher and associates[21] observed that various drugs and materials commonly used in the treatment of teeth, such as zinc-oxide-eugenol paste, eugenol, calcium hydroxide, mercury, and amalgam, significantly reduced the oxygen consumption of bovine pulp tissue. Very little information has been obtained, however, concerning the effect of local anesthetics on the metabolic activity of dental pulp tissue. This has been due partly to the difficulty of obtaining sufficient quantities of pulp tissue for experimental purposes and partly to the physical inaccessibility of such tissues. Recently, interest has been shown in pulpal physiology as evidenced by several studies of the endogenous respiration of dental pulp.[22-25] Since the application of the Warburg technique in previous studies has yielded useful information of the effect of local anesthetics on the metabolism of several different tissues,[1-20] this method was applied to a study of the effects of several local anesthetics on the respiratory activity of incisor pulp tissues of albino rats. Three local anesthetics commonly used in dental practice—procaine, Xylocaine, and Primacaine—were used in this study.

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EXPERIMENTAL PROCEDURES

For each determination of the rate of oxygen utilization, pulpal tissues were obtained from the incisor teeth of six adult male albino rats of the Sprague-Dawley strain which were sacrificed by decapitation. After being carefully stripped from the canals, the pulps were pooled and placed in cold (15° C.) Krebs-Ringer phosphate solution (pH 7.44) in the short interim before the effect of anesthetics on their respiration was determined. Oxygen uptake of the tissue was measured by the "direct method" of Warburg, as described in a previous publication,[25] with only minor variations. Warburg flasks, each of 15 ml. capacity, were utilized—two as thermobarometers and two for determination of oxygen respiration. Krebs-Ringer phosphate solution (2.8 ml. at pH 7.44) was used as the suspending medium in the main chamber of each flask. A temperature of 38° C. was maintained, and oxygen was used as the gas phase in all tests. In one of the flasks employed for determination of oxygen consumption, 0.2 ml. of either procaine, Xylocaine, or Primacaine was placed in the side arm, and 0.2 ml. of Krebs-Ringer phosphate solution was placed in the side arm of the other oxygen flask, which was employed as the control. At the time of the experiment, the pooled pulpal tissue was blotted and weighed, and 125 ± 2 mg. of tissue (wet weight) was added to each reaction flask. The flasks were then conditioned in the water bath (38° C.) for fifteen minutes. The manometers were closed and adjusted at the end of the conditioning period. Oxygen consumption was then determined for thirty minutes, at the end of which time the anesthetic solution in the side arm of the experimental flask and the Krebs-Ringer phosphate solution in the side arm of the control flask were added to the pulp tissue and suspending fluid of the respective flasks. Oxygen consumption was then determined for a second thirty-minute period, after which the nitrogen content of the pulpal tissue and suspending medium of each oxygen flask was determined by standard micro-Kjeldahl procedures.[26] Nitrogen content of two samples of the anesthetic solution, similar in concentration and volume to the anesthetic solution used in the experimental flasks, was also determined. The average nitrogen content of the anesthetic solution only was subtracted from the nitrogen of the suspending fluid containing tissue in order to establish the amount of nitrogen in the fluid attributable to pulpal tissue. Oxygen consumption was then calculated for the two thirty-minute time intervals on the basis of wet weight and nitrogen content of pulpal tissue. Differences in the oxygen uptake of the anesthetized and unanesthetized tissues were calculated on the basis of the following formula:

Difference in μl O_2 uptake =

μl O_2 produced by unanesthetized pulp during first 30 minutes minus
μl O_2 produced by anesthetized pulp during second 30 minutes

minus

μl O_2 produced by unanesthetized pulp during first 30 minutes minus
μl O_2 produced by unanesthetized pulp during second 30 minutes

RESULTS

Procaine, Xylocaine, and Primacaine were each tested on pulpal tissue in final concentrations of 200 mg., 133 mg., and 66 mg. per cent (6 mg., 4 mg., and 2 mg. per final volume of 3 ml.) of suspending fluid. Eight separate tests were made for each concentration of anesthetic. The data obtained are summarized in Table I and depicted graphically in Fig. 1. In Table I, the mean oxygen uptake and the difference in oxygen uptake of unanesthetized and anesthetized pulp tissues, calculated on the basis of wet weight and nitrogen content, are shown for each concentration of anesthetic. Critical ratios (difference between the means divided by its standard error), calculated for comparison of the significance of the differences noted in the action of the anesthetics on pulpal tissue, are also shown in Table I. In Fig. 1, the differences in oxygen consumption of the various tests are depicted graphically when calculated on the basis of the nitrogen content of the tissue.

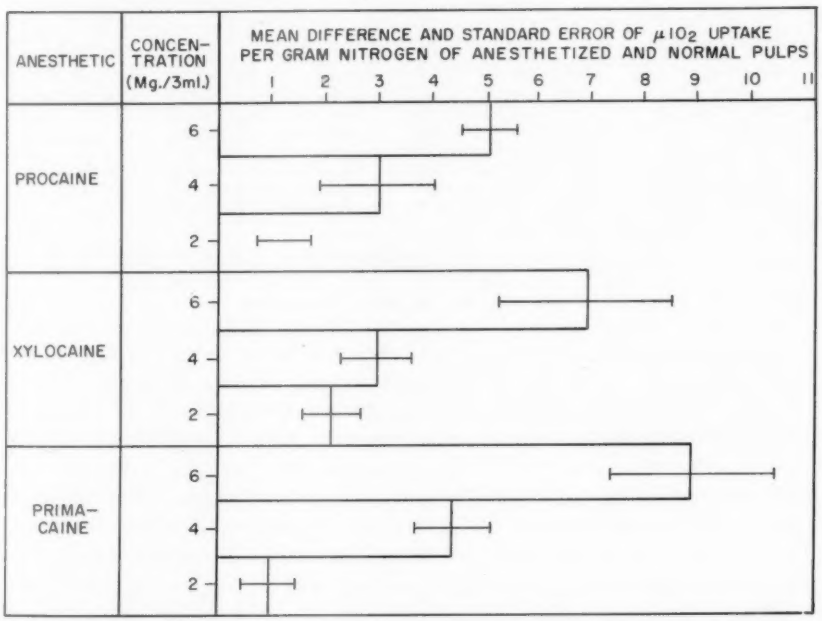

Fig. 1.—The effects of procaine, Xylocaine, and Primacaine on the oxygen uptake of rat incisor pulp.

From the data presented, it can be seen that procaine, Xylocaine, and Primacaine depress the oxygen uptake of pulpal tissue, approximately in proportion to the concentration of the anesthetic. There is considerable variation, however, in the action of a given concentration of anesthetic on pulpal tissue when tested at different times and on different tissues. Generally, the less the concentration of the anesthetic, the greater were such variations.

TABLE I. THE EFFECT OF ANESTHETICS

ANESTHETIC	CONCENTRATION‡ (MG./3 ML.)	MICROLITERS* OXYGEN UPTAKE PER GRAM TISSUE (WET WEIGHT)		DIFFERENCE† MICROLITERS O_2 UPTAKE PER GRAM TISSUE (WET WEIGHT)	
		NORMAL PULP	ANESTHETIZED PULP	NORMAL PULP VS. ANESTHETIZED PULP	
		MEAN AND STANDARD ERROR	MEAN AND STANDARD ERROR	MEAN AND STANDARD ERROR	STANDARD DEVIATION
Procaine	6	0.1444 ± 0.0105	0.1134 ± 0.0064	0.0497 ± 0.0062	0.0186
	4	0.1372 ± 0.0084	0.0978 ± 0.0087	0.0304 ± 0.0117	0.0330
	2	0.1247 ± 0.0099	0.1009 ± 0.0087	0.0122 ± 0.0053	0.0151
Xylocaine	6	0.1456 ± 0.0092	0.0654 ± 0.0106	0.0739 ± 0.0124	0.0351
	4	0.1289 ± 0.0166	0.0764 ± 0.0102	0.0312 ± 0.0069	0.0193
	2	0.1320 ± 0.0145	0.0947 ± 0.0134	0.0262 ± 0.0060	0.0177
Primacaine	6	0.1304 ± 0.0113	0.0353 ± 0.0044	0.0962 ± 0.0146	0.0412
	4	0.1210 ± 0.0108	0.0582 ± 0.0095	0.0443 ± 0.0088	0.0249
	2	0.1006 ± 0.0056	0.0837 ± 0.0080	0.0110 ± 0.0055	0.0156

CRITICAL RATIOS (WET WEIGHT)

Xylocaine	Procaine vs. *Xylocaine*	Procaine vs. *Primacaine*	Xylocaine vs. *Primacaine*
6 mg. vs. 4 mg. = 3.01			
6 mg. vs. 2 mg. = 3.46	6 mg. vs. 6 mg. = 1.72	6 mg. vs. 6 mg. = 2.91	6 mg. vs. 6 mg. = 1.17
4 mg. vs. 2 mg. = 0.55	6 mg. vs. 4 mg. = 1.95	6 mg. vs. 4 mg. = 0.49	6 mg. vs. 4 mg. = 1.95
Procaine	6 mg. vs. 2 mg. = 2.64	6 mg. vs. 2 mg. = 4.50	6 mg. vs. 2 mg. = 4.62
6 mg. vs. 4 mg. = 1.44	4 mg. vs. 6 mg. = 2.56	4 mg. vs. 6 mg. = 3.52	4 mg. vs. 6 mg. = 4.04
6 mg. vs. 2 mg. = 4.46	4 mg. vs. 4 mg. = 0.06	4 mg. vs. 4 mg. = 0.94	4 mg. vs. 4 mg. = 1.17
4 mg. vs. 2 mg. = 1.42	4 mg. vs. 2 mg. = 0.32	4 mg. vs. 2 mg. = 1.49	4 mg. vs. 2 mg. = 2.30
Primacaine	2 mg. vs. 6 mg. = 4.57	2 mg. vs. 6 mg. = 5.42	2 mg. vs. 6 mg. = 4.43
6 mg. vs. 4 mg. = 3.05	2 mg. vs. 4 mg. = 2.13	2 mg. vs. 4 mg. = 3.12	2 mg. vs. 4 mg. = 1.69
6 mg. vs. 2 mg. = 5.50	2 mg. vs. 2 mg. = 1.60	2 mg. vs. 2 mg. = 0.16	2 mg. vs. 2 mg. = 1.85
4 mg. vs. 2 mg. = 3.20			

*Microliters of oxygen utilized during second 30 minutes.

†Difference in μl O_2 uptake = (μl O_2 produced by unanesthetized pulp during first 30 minutes — μl O_2 produced by anesthetized pulp during second 30 minutes) — ( )

‡Eight separate tests made for each concentration of anesthesia.

The oxygen consumption of rat incisor pulp decreased an average of 29.5 per cent in the presence of 200 mg. per cent of procaine. When 133 mg. per cent was used, the mean decrease in oxygen consumption was 17.3 per cent. With 66 mg. per cent of procaine, the mean decrease in oxygen consumption was 10.5 per cent.

Xylocaine depressed oxygen consumption of pulp tissue more than did procaine. When 200 mg. per cent was used, oxygen consumption was reduced 49.3 per cent; 133 mg. per cent and 66 mg. per cent of Xylocaine lowered oxygen consumption of pulp tissue 24.0 per cent and 16.1 per cent, respectively. Primacaine in concentrations of 200, 133, and 66 mg. per cent reduced oxygen consumption of pulp tissue 54.8 per cent, 34.0 per cent, and 12 per cent, respectively.

While there appears to be considerable reduction in oxygen consumption of pulpal tissue by the anesthetics, statistical analysis of the data indicates only a few consistently significant trends in reduction in regard to either concentration or type of anesthetic. In the various comparisons made in the statistical analysis, critical ratios of 2 or more were considered significant, while those less than 2 were considered not to be significant. In each instance

ON OXYGEN UPTAKE OF RAT INCISOR PULP

	MICROLITERS* OXYGEN UPTAKE PER GRAM NITROGEN CONTENT		DIFFERENCE† MICROLITERS O_2 UPTAKE PER GRAM NITROGEN CONTENT		
	NORMAL PULP	ANESTHETIZED PULP	NORMAL PULP VS. ANESTHETIZED PULP		
COEFFICIENT OF VARIATION	MEAN AND STANDARD ERROR	MEAN AND STANDARD ERROR	MEAN AND STANDARD ERROR	STANDARD DEVIATION	COEFFICIENT OF VARIATION
37.42	13.57 ± 0.069	11.39 ± 0.063	5.11 ± 0.55	1.55	30.33
108.55	13.42 ± 1.07	9.45 ± 0.95	2.99 ± 1.06	2.98	99.67
123.77	11.25 ± 1.06	9.44 ± 0.96	1.26 ± 0.52	1.47	116.67
47.50	13.61 ± 0.91	6.23 ± 1.06	6.99 ± 1.62	4.68	65.81
61.86	12.71 ± 1.77	7.29 ± 0.98	3.00 ± 0.67	1.89	63.00
67.56	12.12 ± 1.38	8.53 ± 1.24	2.19 ± 0.47	1.33	60.73
42.83	11.89 ± 1.06	3.19 ± 0.39	8.98 ± 1.37	3.89	43.32
56.21	10.74 ± 1.02	5.13 ± 0.80	4.42 ± 0.77	2.17	49.10
141.82	9.21 ± 0.60	7.69 ± 0.78	1.00 ± 0.50	1.42	142.00

CRITICAL RATIOS (NITROGEN BASIS)

Xylocaine	Procaine	Procaine	Xylocaine
6 mg. vs. 4 mg. = 2.27	vs.	vs.	vs.
6 mg. vs. 2 mg. = 2.84	*Xylocaine*	*Primacaine*	*Primacaine*
4 mg. vs. 2 mg. = 0.99	6 mg. vs. 6 mg. = 1.09	6 mg. vs. 6 mg. = 2.61	6 mg. vs. 6 mg. = 1.17
Procaine	6 mg. vs. 4 mg. = 2.45	6 mg. vs. 4 mg. = 0.73	6 mg. vs. 4 mg. = 1.95
6 mg. vs. 4 mg. = 1.78	6 mg. vs. 2 mg. = 4.06	6 mg. vs. 2 mg. = 5.55	6 mg. vs. 2 mg. = 4.62
6 mg. vs. 2 mg. = 5.07	4 mg. vs. 6 mg. = 2.06	4 mg. vs. 6 mg. = 3.46	4 mg. vs. 6 mg. = 4.04
4 mg. vs. 2 mg. = 1.47	4 mg. vs. 4 mg. = 0.01	4 mg. vs. 4 mg. = 1.10	4 mg. vs. 4 mg. = 1.17
Primacaine	4 mg. vs. 2 mg. = 0.69	4 mg. vs. 2 mg. = 1.70	4 mg. vs. 2 mg. = 2.30
6 mg. vs. 4 mg. = 2.89	2 mg. vs. 6 mg. = 3.35	2 mg. vs. 6 mg. = 5.25	2 mg. vs. 6 mg. = 4.43
6 mg. vs. 2 mg. = 5.47	2 mg. vs. 4 mg. = 2.05	2 mg. vs. 4 mg. = 3.40	2 mg. vs. 4 mg. = 1.69
4 mg. vs. 2 mg. = 3.72	2 mg. vs. 2 mg. = 1.33	2 mg. vs. 2 mg. = 0.36	2 mg. vs. 2 mg. = 1.85

$$\left(\begin{array}{l}\mu l\ O_2 \text{ produced by unanesthetized pulp during first 30 minutes}\end{array} - \begin{array}{l}\mu l\ O_2 \text{ produced by unanesthetized pulp during second 30 minutes}\end{array}\right)$$

there is a statistically significant difference when comparisons are made between concentrations of 200 mg. per cent and 66 mg. per cent, regardless of whether comparisons are made of the same or different anesthetics. When comparisons are made between 200, 133, and 66 mg. per cent of anesthetic, some of the differences in the suppression of oxygen consumption are significant and others are not. At any rate, there is no consistent difference when comparisons are made between different concentrations of the same anesthetic or between the same or different concentrations of different anesthetics when the differences in concentration vary only 66 mg. per cent.

DISCUSSION

The oxidative phases of cellular metabolism are dependent on catalytic enzymes. When the activity of such catalysts can be inhibited by a substance which acts as a poison, information on their function in cellular metabolism and on the specific action of the poison can be obtained. Consequently, if anesthetics inhibit the oxidative metabolism of pulp tissue, the study of their action should give some indications of the mechanisms of anesthesia and of the specific manner in which local anesthetics are toxic. Previous investigations with tissues other than dental pulps have given some indication of the

action of anesthetics. Thimann,[27] as a result of his studies, attributed the anesthetic action of cocaine and its analogues to their structural resemblance to acetylcholine. He suggested that cocaine and acetylcholine may compete for the same receptor molecule in cells. When acetylcholine combines with a receptor in a cell, the cell is stimulated; when cocaine combines with the receptor, there is a loss of irritability and anesthesia is produced. The action of local anesthesia was regarded by Thimann as a matter of competitive inhibition. Cook and McDevitt[14] found that Diothane (0.0037 M), Nupercaine (0.0032 M), procaine (0.05 M), cocaine (0.33 M), and Metycaine (0.5 M) depressed the respiratory activity of yeast cells and rat liver tissue in a manner roughly proportional to the toxicity of the anesthetic. Diothane and Nupercaine, the most toxic of the anesthetics, killed the yeast cells, while the other less toxic anesthetics only depressed or inhibited the respiration of such cells. Wollenberger[17] found that narcotics, in concentrations producing a moderately severe failure of isolated dog heart, markedly reduced the respiration of dog and guinea pig heart muscle slices. On the other hand, local anesthetics, such as cocaine, procaine, and tetracaine, at several times the concentration which produced a moderately severe failure of the isolated dog heart, had no effect on the respiration of dog and guinea pig heart muscle. Such local anesthetics in similar concentrations did not inhibit anaerobic glycolysis of heart muscle slices. Ryman and Walsh,[7] utilizing brain homogenate and yeast cells *(Torulopsis utilis)*, found that cocaine inhibited fermentation by blocking pyruvate metabolism through the inhibition of carboxylase. Tissue toxicity of cocaine was attributed to the ability of cocaine to block the entry of 2-carbon fragments into the tricarboxylic acid cycle, either by inhibiting a condensing enzyme or by preventing the formation of available acetyl groups. In a later study, Ryman and Walsh[8] presented evidence that cocaine inhibits cellular respiration by blocking the entry of active acetate into the tricarboxylic acid cycle.

The present study indicates that Primacaine, Xylocaine, and procaine depress but do not inhibit oxygen consumption of pulp tissues. In lower concentrations there were no significant differences between the depressive action of the anesthetics. There may be some correlation between the experimental decrease in oxygen consumption of the tissues and the clinical potency of the anesthetics.

SUMMARY

Determinations were made of the effect of procaine, Xylocaine, and Primacaine in concentrations of 0.200 Gm., 0.133 Gm., and 0.066 Gm. per cent on the oxygen consumption of rat incisor pulp tissues. Calculations were made on the basis of wet weight and nitrogen content of the tissues.

Although somewhat variable in action, all of the local anesthetics depressed oxygen consumption of pulpal tissues. In lower concentrations, and when the difference in anesthetic concentrations varied by 66 mg. per cent, there were no consistently significant differences in the decrease in oxygen

consumption when such data were analyzed statistically. Significant differences were found consistently in the effect of the anesthetics when comparisons were made between the highest and lowest concentrations of anesthetics.

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Section by the

ARMED FORCES AND PUBLIC HEALTH SERVICE

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DOUBLE LIP

Report of a Case

Albert F. Morgan, Captain, USAF (DC), Frank W. Stewart, D.M.D.,** and Ignatius J. Stein, Lieutenant Colonel, USAF (MC)****

AN ADDITIONAL fold in the mucosal portion of the lip that can be seen without difficulty is sometimes referred to as a double lip. It occurs most frequently in the upper lip, although a case has been reported in the lower lip.[1] According to Thoma,[2] it is uncommon and only a few cases are reported in the literature.

In origin, the double lip can be congenital or acquired, the acquired form being accentuated or possibly caused by being sucked constantly and being drawn between the teeth. Clinically, the lip appears slightly overfull when relaxed (Fig. 1), but when tensed the double lip is quite evident (Fig. 2) and resembles a Cupid's bow.

CASE REPORT

A 32-year-old Air Force Chaplain was seen as an outpatient in the dental clinic for evaluation of his upper lip. He stated that he had experienced no discomfort from this condition but he felt that it was esthetically undesirable and that it impaired his speech to some degree.

On April 6, 1959, he was admitted to this Hospital. The physical examination was within normal limits, with the exception of the hypertrophied mucosa under the upper lip.

After induction of bilateral infraorbital block anesthesia, with the usual preparation and drapes, the lip was retracted to expose the redundant tissue. The tissue was grasped with three Allis forceps and the mass was outlined in an elliptical manner from the midline to the right lateral commissure. By sharp dissection, this incision was extended in the form

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of a "V" well into the submucosal tissues of the lip. This wedge of tissue was then dissected free and removed. The few small bleeders were ligated with 00000 catgut. The mucosal margin was undermined and the wound was closed in layers with 00000 catgut and 0000 silk without drains. The same procedure was then carried out on the left side. The

Fig. 1.

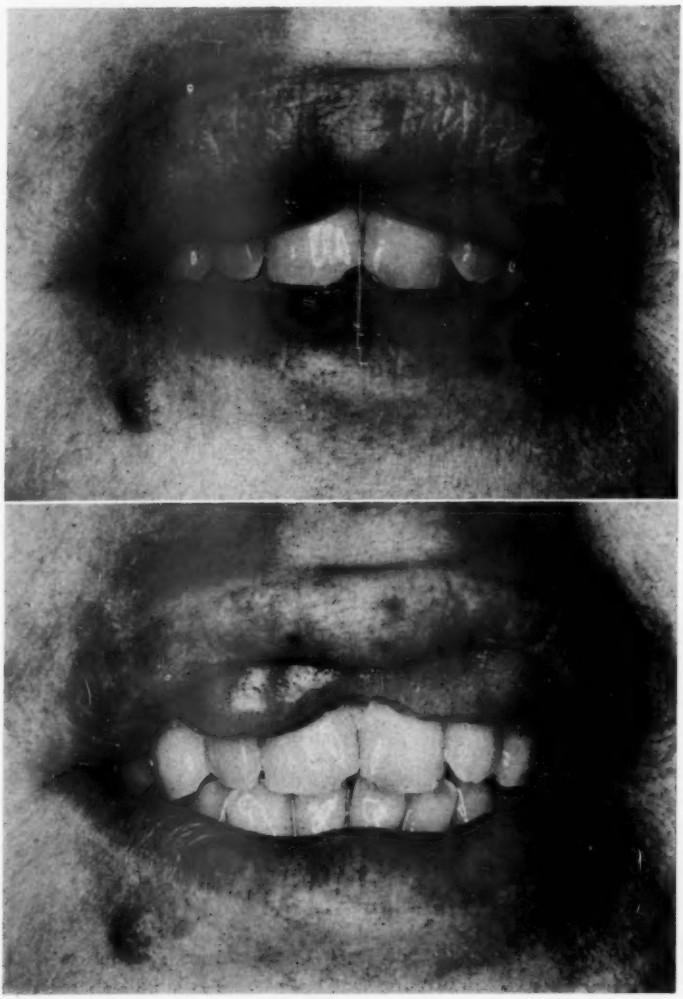

Fig. 2.

immediate postoperative result was good (Fig. 3). A rolled-gauze pressure dressing was placed under the lip and the patient returned to his room in good condition. Postoperatively, the patient had only minimal edema and discomfort. He was discharged on the fourth hospital day.

Fig. 3.

Fig. 4.

The sutures were removed on the fifth postoperative day (Fig. 4), and the operative wound appeared to be healing well. On the twelfth postoperative day the patient was seen again, and at this time healing was almost complete (Fig. 5). He stated that at no time had he been uncomfortable.

Histopathologic Report (Dr. Clay, Lackland Air Force Base, Texas).—Tissue consistent with double lip. The sections are covered by squamous mucosa with rather large areas of ulceration. The submucosa contains many mucinous salivary glands and some have a moderate lymphocytic infiltrate. There is submucosal hemorrhage. The glands are probably more numerous than normal for this area.

Fig. 5.

SUMMARY

A case of double lip is reported. This is an uncommon anomaly appearing in either the upper or lower lip. Excision of this abnormality is a relatively simple surgical procedure, and excellent cosmetic results are obtainable.

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THE EFFECT OF PILOCARPINE STIMULATION ON THE HISTOLOGIC APPEARANCE AND THE SODIUM AND POTASSIUM CONTENT OF RAT SUBMAXILLO-SUBLINGUAL GLANDS

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IT WAS the purpose of this experiment to study the histologic appearance and the concentrations of sodium and potassium within the submaxillary glands of rats after sialogogue administration. This study represents a phase of a broad investigation of salivary gland exhaustion in both human subjects and animals. Of primary interest was the question of whether, under strenuous prolonged stimulation, the glands were depleted of these cations or whether the source of these elements was sufficient to maintain relatively constant levels within the glands. No effort was made to separate completely the submaxillary and sublingual glands. The major sublingual[1] lies on the anterior and lateral surface of the submaxillary gland and is difficult to separate therefrom, since it often appears as a lobe of the larger gland. Since the extent and exact location of all portions of this sublingual gland are not universally predictable, we chose to extirpate the entire gland complex. The chemical analyses were thus carried out on a variable proportion of submaxillary and sublingual gland tissue. The minor sublingual gland[1] was not removed.

MATERIAL AND METHODS

A total of fifty adult male Wistar rats were used. The animals were divided into control and experimental groups as follows: Group T_1—twenty animals received no drug (controls); Group T_2—ten animals received pilocarpine (10 mg. per kilogram of body weight) and were sacrificed with chloroform thirty minutes later; Group T_3—ten animals received pilocarpine (20 mg. per kilogram of body weight) and were sacrificed thirty minutes later; and Group T_4—ten animals received pilocarpine (40 mg. per kilogram of body weight) and a repeated dose of the same size fifteen minutes later and were sacrificed thirty minutes after the initial dose.

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The opinions expressed herein are those of the authors and are not to be construed as representing official United States Air Force policy.
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Every gland, right and left, was analyzed. Immediately upon extirpation, a section of each gland was removed, cleared of gross blood, weighed, and placed in 1.0 ml. of ion-exchange water in a power-driven ground-glass homogenizer. After complete homogenization, 2.5 ml. of 4 per cent trichloroacetic acid was added; the mixture was shaken thoroughly and allowed to stand for at least twenty minutes. Then 6.5 ml. of ion-exchange water was added, and the mixture was shaken thoroughly and centrifuged at 3,000 r.p.m. for ten minutes. Aliquots of the supernate were aspirated into the hydrogen-oxygen flame of a Beckman DU flame spectrophotometer equipped with photomultiplier and spectral energy recording adapter. Working standards were dilutions of a stock serum standard containing the following: sodium, 144 mEq. per liter; potassium, 5.0 mEq. per liter; calcium, 5.0 mEq. per liter; phosphorus, 2.2 mEq. per liter; and magnesium, 2.0 mEq. per liter. All samples were analyzed in duplicate. All samples and standards contained 1 per cent trichloroacetic acid. A portion of each gland was placed in formalin, and the sections prepared therefrom were stained with hematoxylin and eosin.

The total weight for each gland was recorded, and the means, differences of means, ranges, and standard deviations for sodium, potassium, and sodium/potassium were computed. In addition, statistical tests were performed to determine whether or not significant differences in gland weight existed between the right and left glands.

RESULTS AND DISCUSSION

For each of the three variables under study—sodium, potassium, and sodium/potassium—no significant difference was found in the means for the right and left glands.

TABLE I. MEANS, STANDARD DEVIATIONS, AND SAMPLE SIZES (BY TREATMENT)

	MEANS				
	PILOCARPINE DOSAGE				
	NONE (CONTROLS)	10 MG./KG. (T_2)	20 MG./KG. (T_3)	80 MG./KG. (T_4)	STANDARD DEVIATIONS
Sodium*	1.44	1.81	2.36	2.28	0.31
Potassium*	4.12	3.20	2.40	2.68	0.40
Sodium/potassium	0.35	0.57	0.99	0.87	0.17
Number of animals	20	10	10	10	

*Milligram per gram of gland.

Highly significant differences were found in the sodium levels when the means for the four groups were compared (Table I). With pilocarpine administration, the mean levels of sodium in the glands at the time of sacrifice were greater than the mean sodium value for the control animals. These increases were statistically significant ($P < .01$). The effect of the drug was roughly linear up to a dosage of 20 mg. per kilogram of body weight, but when the dosage was increased to 80 mg. per kilogram (T_4) the mean was less than the mean for T_3. This decrease was not significant, but it did point out that the effect of the drug tended to level off at a dosage in the vicinity of that given to group T_3.

The glands of the pilocarpine-treated animals contained significantly ($P < .01$) less potassium than did the glands of the control animals. The sodium/potassium ratio was thus higher in treated animals. The potassium means (Table I) decreased from the control mean in approximately linear fashion for the dosages of 10 and 20 mg. per kilogram. These decreases were significant at the 1 per cent level. When a dosage of 80 mg. per kilogram was administered, however, the potassium mean was higher than the mean for the 20 mg. per kilogram dose. This reversal in the linear trend was significant ($P < 0.05$).

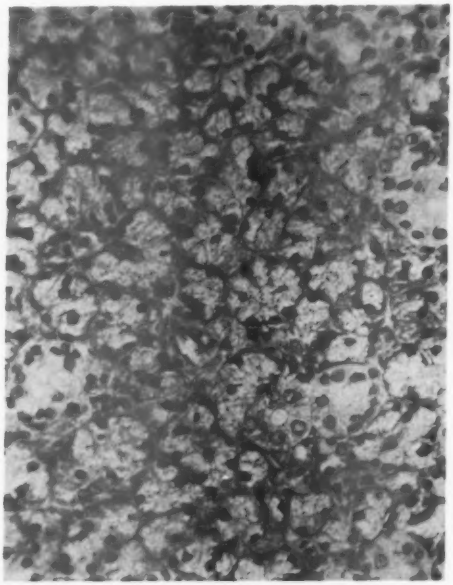

Fig. 1.—Acinar portion of submaxillary gland of untreated Wistar rat. Note normal acini and widely dispersed ducts. (Magnification, ×400; reduced ¼.)

These results indicate that when salivary flow is stimulated by pilocarpine the source of sodium to the gland is such that the sodium level within the gland not only is maintained but is increased significantly. The potassium source to the gland is not capable of maintaining the gland potassium level under pilocarpine stimulation, and consequently glandular potassium decreases significantly.

The findings of this portion of the study are in accord with previous results found for other animals. Under chorda tympani stimulation, the cat submaxillary gland was able to maintain its potassium content at a constant level. When stimulated with pilocarpine, however, potassium was lost.[2] It has also been shown[3] that the submaxillary glands of both dogs and cats under chorda tympani stimulation gain water and sodium without a substantial loss of other elements. With pilocarpine, however, the glands gain water and sodium but lose potassium.

Histologic examination of the glands revealed the following:

The sublingual gland showed large acini composed of mucous cells with abundant, pale, slightly basophilic cytoplasm. There was no observable change in these cells following pilocarpine treatment.

The submaxillary gland proper showed smaller serous-appearing acini and smaller cells with granular pink cytoplasm. These showed marked changes after pilocarpine administration. There was a decrease in the amount of cytoplasm, so that the nuclei appeared closely packed and the individual acinus was indistinct. This change was most marked at the center of the lobule, and there often appeared to be a periphery of less involved tissue.

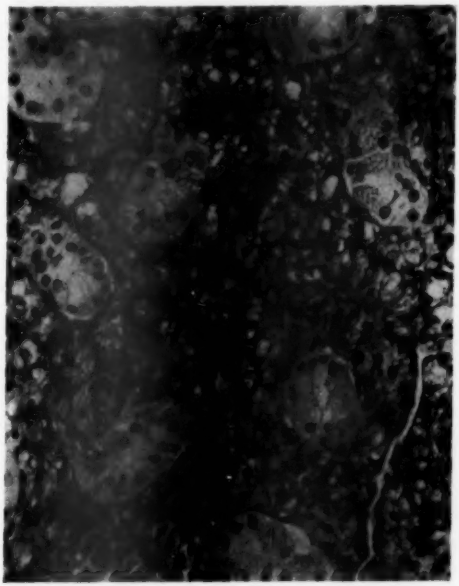

Fig. 2.—Acinar portion of submaxillary gland of Wistar rat treated with pilocarpine, showing effect of strong stimulation on acini and prominence of duct system. (Magnification, ×400; reduced ¼.)

The histologic changes due to pilocarpine were consistent with stimulation. There was some variation in the degree of change from animal to animal and even contralaterally in the same animal. The glands of animals receiving the highest dosage (T_4) consistently showed the most marked changes, but many of the rats that received only 10 mg. per kilogram (T_2) showed involvement histologically comparable to the groups injected with larger amounts.

These histologic findings may be compared with those of Rawlinson,[4] who studied the cat submaxillary gland. He found that chorda tympani stimulation (one-half to three hours), with the cervical sympathetic trunk cut, led to no definite or constant changes in the demilune cells. Mucous cells underwent

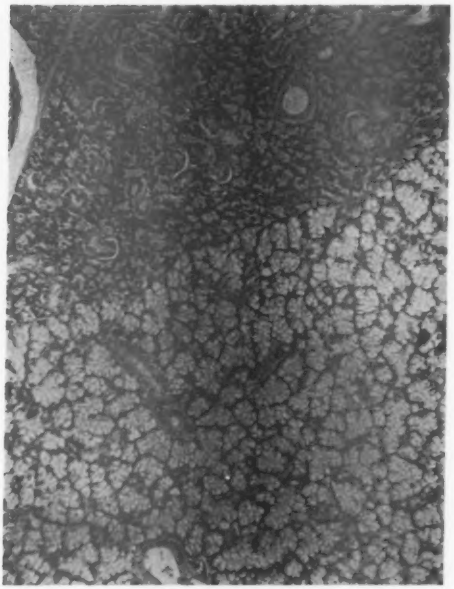

Fig. 3.—Submaxillary (top) and sublingual glands of untreated Wistar rat. (Magnification, ×100; reduced ¼.)

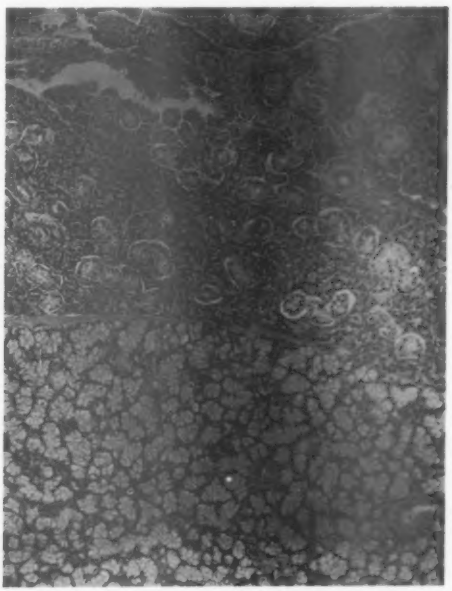

Fig. 4.—Submaxillary (top) and sublingual glands of pilocarpine-treated Wistar rat. The intense stimulation produced no alterations in mucous acini. Note prominence of duct system in submaxillary portion. (Magnification ×100; reduced ¼.)

changes in size and staining characteristics. Stimulation of the sectioned cervical sympathetic trunk for two to three hours produced no definite changes in the mucous cells, but the demilune cells became smaller and, if stimulation was prolonged, developed vacuoles.

Bixler and associates[5] also found that in rats "stomach-tubed" with pilocarpine the most pronounced effect was upon the acinar portion of the gland and there was a marked decrease in the number of tubular cells containing granules. Prolonged stimulation brought on no apparent submaxillary gland pathosis.

SUMMARY

After the administration of graded doses of pilocarpine to Wistar rats, the following effects were observed:

1. Mean sodium levels were in all instances significantly higher in the treated animals than in the controls, while the reverse held true for the gland potassium content. The sodium/potassium ratio was consistently higher in the pilocarpine-treated groups.

2. There was no observable histologic change in the mucous acini of the sublingual gland after pilocarpine. The acini of the submaxillary glands showed marked changes after pilocarpine; there was a decrease in the amount of cytoplasm so that the nuclei appeared closely packed, there was less distraction of the individual acinus, and there was greater prominence of the ducts.

The authors express appreciation to Muriel Huggins for the statistical analysis, to Airmen J. F. McAnear and R. R. Hogue for technical assistance, and to Dr. Joseph Muhler for invaluable suggestions throughout the study.

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2. Wills, J. H., and Fenn, W. O.: Potassium Changes in Submaxillary Glands During Stimulation, Am. J. Physiol. 124: 72, 1938.
3. Wills, J. H.: Electrolyte Changes in Submaxillary Glands During Stimulation, Am. J. Physiol. 135: 164, 1941.
4. Rawlinson, H. E.: Cytological Changes After Autonomic and Adrenalin Stimulation of the Cat's Submaxillary Gland, Anat. Rec. 57: 289, 1933.
5. Bixler, D., Webster, R. C., and Muhler, J. C.: The Effect of Pilocarpine on the Submaxillary Gland of the Rat, J. D. Res. 37: 649, 1958.

ANNOUNCEMENTS

American Society of Psychosomatic Dentistry and Medicine, Inc.

The Society's annual meeting will be held at the Shoreham Hotel in Washington, D. C., from Friday evening, March 11, to Sunday afternoon, March 13, 1960. Lectures and round-table discussions will be given by outstanding authorities in the fields of semantics, linguistics, psychosomatics, and hypnosis.

The detailed program may be obtained from Dr. Jesse Caden, Chairman, Program Committee, 5213 Connecticut Ave., Washington 15, D. C.

First District Dental Society

The Section on Oral Surgery of the First District Dental Society, State of New York, will meet at the Hotel Statler in New York City on Wednesday, Feb. 17, 1960, at 8 P.M. The essayist will be Laszlo Schwartz, and his subject will be "Diagnosis and Management of Temporomandibular Joint Disturbances."

Greater Washington Periodontal Society

Several diplomates of the American Board of Periodontology living in the nation's capital have formed a local organization known as the Greater Washington Periodontal Society. The Society's general objective will be to exchange, disseminate, and evaluate data on periodontology.

The Society's eligibility rules require that members have a teaching or research appointment or have completed graduate work in the field of periodontology and be active participants in the Society's activities. Meetings will be held about twice yearly.

Present officers are Dr. Paul M. Baer, National Institute of Dental Research, president; Major Charles F. Sumner, III, Walter Reed Army Medical Center, vice-president; Dr. Albert G. Paulsen, treasurer; Lieutenant Commander Perry C. Alexander, U. S. Naval Dental School, Bethesda, Maryland, secretary; and Captain Alfred L. Raphael, U. S. Naval Dispensary in Washington, chairman of Membership Committee. The next meeting is to be held in April, 1960.

Twenty-Eighth Annual Postgraduate Clinic of the District of Columbia Dental Society

The Postgraduate Clinic will be held March 13 to 16, 1960, at the Shoreham Hotel in Washington, D. C. A full program of scientific sessions will include limited-attendance clinics, panel discussions, projected clinics, table clinics, a "Lunch and Learn" meeting, motion pictures, and scientific exhibits.

Detailed information may be obtained from the District of Columbia Dental Society, 1835 Eye St., N.W., Washington 6, D. C.

University of Alabama

The University of Alabama School of Dentistry will offer the following refresher courses during the month of May:

Pedodontics for the General Practitioner. May 7 and 8, 1960. Sidney B. Finn.

Root Canal Therapy Followed by Apicoectomy. May 11 to 13, 1960. Adeeb E. Thomas.

Anatomy of the Head and Neck. May 23 to 25, 1960. Harry Sicher.

Hypnosis Applied to Dentistry. May 27 to 29, 1960. William T. Heron.

Further information may be obtained from the Director, Refresher Course Program, University of Alabama School of Dentistry, 1919 7th Ave. South, Birmingham, Alabama.

Boston University School of Medicine

ORAL SURGERY

The Oral Surgery Section, Department of Stomatology, Division of Graduate Studies, offers to dentists a one-year course in oral surgery. This course has been planned to meet the requirements of the American Board of Oral Surgery, providing a foundation for the clinical internship and residency training leading to qualification for the practice of oral surgery as a specialty.

This course, given annually, consists of one academic year and is designed to present by lectures, clinical demonstrations, operative clinics, and laboratory exercises a systematic basic review of the clinical phases of oral surgery, coordinated and correlated to the pertinent preclinical sciences. The course covers the fundamental principles of diagnosis and treatment of the various manifestations in the field of oral surgery, with specific emphasis on etiology and pathology, and is planned to provide a foundation for other clinical training leading to qualification for the practice of oral surgery as a specialty. Instruction is given in oral surgery, principles of general surgery, radiology, general and oral pathology, oral medicine, physical diagnosis, medicine, dermatology, clinical laboratory procedures, anesthesia, physiology, biochemistry, pharmacology, anatomy (head and neck), bacteriology, surgical prosthesis, and oncology.

The course is under the direction of Dr. Kurt H. Thoma, Professor of Oral Surgery, assisted by a large staff of lecturers and instructors.

ORTHODONTICS

The Orthodontics Section, Department of Stomatology, Division of Graduate Studies, offers a sixteen-consecutive-month course (two academic years) intended for those individuals who wish to prepare themselves for the practice of orthodontics as a specialty. This course consists of lectures, clinical demonstration, clinics, and laboratory exercises constituting the various phases pertinent to this specialty. Courses are given in the preclinical sciences pertaining to this field.

PROSTHETICS

The Prosthetic Section, Department of Stomatology, Division of Graduate Studies, offers a sixteen-consecutive-month course (two academic years intended for those individuals who wish to prepare themselves for the practice of prosthodontics as a specialty. This course consists of lectures, clinical demonstrations, operative clinics, and laboratory exercises in the various clinical phases of prosthetics. This phase is coordinated and correlated to the pertinent preclinical sciences.

ENDODONTICS

The Endodontic Section, Department of Stomatology, Division of Graduate Studies, offers a one-year course to dentists in the field of endodontics. This course consists of lectures, clinical demonstrations, operative clinics, and laboratory exercises constituting the various phases pertinent to this specialty. Instruction is given in the preclinical sciences pertaining to this field.

For applications or further information concerning the above courses please apply to Department of Stomatology, Boston University School of Medicine, 80 East Concord St., Boston 18, Massachusetts.

Boston University School of Medicine

The Department of Stomatology, Division of Graduate Studies, School of Medicine, Boston University and the Massachusetts Memorial Hospitals, announces the following post-graduate courses:

Oral Pathology for Oral Surgeons. Jack Bloom, Kurt Thoma, and Henry M. Goldman. Jan. 11 to 16, 1960. $200.00.

Removable Partial Denture Prosthesis. David J. Baraban. Jan. 21 to 23, 1960. $100.00.

Technics in the General Practice of Dentistry. Henry M. Goldman, David J. Baraban, Leo Talkov, Herbert Schilder, Gerald Kramer, Chester Landy, and Harold Berk. March 7 to 12, 1960. $175.00.

Advanced Course in Periodontology. Henry M. Goldman, Bernard S. Chaikin, Gerald M. Kramer, William Pendergast, and Jack Bloom. March 14 to 19, 1960. $250.00.

Full Denture Prosthesis. Chester Landy. March 28 to April 1, 1960. $150.00.

Periodontal Therapy. Henry M. Goldman, Bernard S. Chaikin, Gerald M. Kramer, William Pendergast, Jack Bloom, and Associates. April 4 to 9, 1960. $175.00.

Apicoectomy—Surgical Endodontic Procedures. Herbert Schilder and Leonard Parris. April 18 to 22, 1960. $175.00.

Periodontal Pathology. Henry M. Goldman and Jack Bloom. April 25 to 30, 1960. $250.00.

Pulp Protection in Operative Dentistry. Harold Berk. May 12 to 14, 1960. $100.00.

Periodontal Prosthesis. Leo Talkov, David J. Baraban, Henry M. Goldman, Bernard S. Chaikin, and Gerald M. Kramer. May 16 to 20, 1960. $200.00.

Surgical Procedures in Periodontal Therapy. Lewis Fox and Associates. May 23 to 27, 1960. $200.00.

For further information, write to Director of Post-Graduate Studies, Department of Stomatology, Massachusetts Memorial Hospitals, 750 Harrison Ave., Boston 18, Massachusetts.

Medical College of Virginia

The School of Dentistry in Richmond, Virginia, offers fellowships for graduate study. The fellowships, made available through a teacher's training grant from the National Institute of Dental Research, provide annual stipends of $5,000.00. Persons receiving fellowships may work toward M.S. or Ph.D. degrees in basic science departments.

Information concerning the program may be obtained from the Director of Graduate and Postgraduate Instruction at the school in Richmond.

Albert Einstein Medical Center

The Department of Postgraduate Medical Education announces that a course entitled "Dentistry for the Handicapped Child" will be given by Morris Kelner, D.D.S., and associates on April 25 to 27, 1960. The course is designed to enable the dentist to render adequate and proper treatment for the handicapped child. Instruction will provide a fuller understanding of the pedodontic, pediatric, and psychologic factors as they affect the dental problem of the handicapped child.

The lectures will include a background of physical, mental, and emotional handicapping conditions; their oral manifestations; modifications in approach to chair treatment; modifications of techniques and methods of rendering adequate treatment; preparation of the patient and operator for total treatment under a general anesthetic in the operating room; periodontal, prosthetic, orthodontic, and speech problems; and psychosomatic and medicodental pediatric problems.

The course will be given at the Northern Division of the Albert Einstein Medical Center in Philadelphia, Pennsylvania. Registration, which is limited to ten students, will close April 10, 1960. The fee for the course will be $100.00.

University of Illinois

The College of Dentistry is accepting applications for two- and three-year full-time courses in oral surgery beginning in July, 1960. Both programs carry credit toward a Master of Science degree.

Further information can be obtained from Dr. Daniel M. Laskin, Department of Oral and Maxillofacial Surgery, University of Illinois, 808 S. Wood St., Chicago 12, Illinois.

University of Pennsylvania

The following postgraduate courses will be presented by the School of Dentistry:

Practice Administration. March 7 and 8, 1960. Dr. Harry M. Klenda.
Practical and Simplified Procedures in Crown and Bridge Prosthesis. March 14 to 18, 1960. Dr. Charles B. Sceia.
Extraoral Tracers in Rehabilitation of Function. March 21 to 23, 1960. Dr. Ernest R. Granger.
Pulp Reactions to Operative Procedures. March 25 and 26, 1960. Drs. Samuel Seltzer, I. B. Bender, and Louis I. Grossman.
Complete Denture Prosthesis. March 28 to 31, 1960. Dr. Vincent R. Trapozzano.
Endodontics. March 28 to April 8, 1960. Dr. Louis I. Grossman.
Applied Anatomy. April 20 to 22, 1960. Dr. Harry Sicher.

For further information, please write to Postgraduate Courses, School of Dentistry, University of Pennsylvania, 4001 Spruce St., Philadelphia 4, Pennsylvania.

Temple University School of Dentistry

Applications are now being accepted for the position of Research Fellow and Clinical Instructor in the Department of Endodontia beginning Aug. 1, 1960. Remuneration is $4,200.00 a year.

The position offers the applicant an opportunity to pursue research projects while at the same time instructing students.

Applicants should send information as to background, interest, and clinical experience to Dr. Leonard Parris, Temple University School of Dentistry, Broad Street above Allegheny Ave., Philadelphia 40, Pennsylvania.

Postgraduate Courses at University of Illinois

The College of Dentistry will offer the following postgraduate courses:

Dentistry for Children. March 14 to 18, 1960. This course will deal with caries control, restorative techniques for deciduous teeth, vital pulp therapy, treatment of fractured incisors, premedication of children, interception of malocclusion, and management of oral habits. Dr. Thomas K. Barber, Associate Professor of Pedodontics. Tuition, $100.00.

Dentistry for the Handicapped Child. March 21 to 24, 1960. This course will include discussions of the cleft palate child and the brain-damaged child, with emphasis on office management, premedication, and hospital procedures. Dr. Thomas K. Barber. Tuition, $100.00.

Workshop on the Teaching of Radiology in Dentistry. March 18 and 19, 1960. This course, offered in cooperation with the American Academy of Oral Roentgenology and the W. K. Kellogg Foundation, will include an evaluation of existing curricula in dental radiology at the undergraduate, graduate, and postgraduate levels and a consideration of long-range objectives for the teaching of dental radiology. Moderators will be Dr. Seymour Yale, Head of the Department of Dental Radiology at the University of Illinois, and Dr. Donald T. Waggener, University of Nebraska.

Periodontics in a General Practice. May 4 and 5, 1960. This course will include lectures and demonstrations covering various phases of periodontal disturbances which confront a general practitioner. Dr. Charles G. Maurice. Tuition, $50.00.

For further information, write Division of Postgraduate Education, University of Illinois College of Dentistry, 808 S. Wood St., Chicago 12, Illinois.

New York University

The College of Dentistry will offer the following short-term postgraduate courses:

Periodontia and Oral Medicine (Spanish-language course). March 2 to 25, 1960, 9:30 A.M. to 4 P.M. daily. Dr. Sidney Sorrin and associates.

Periodontia and Oral Medicine (Spanish-language course). March 2 to May 27, 1960, 9:30 A.M. to 4 P.M. daily. Dr. Sidney Sorrin and associates.

Internal Medicine With Application to Dentistry and Oral Surgery. March 9 to May 28, 1960. Dr. Adolph R. Berger and staff.

Technique of Exodontia and Relation of Oral Surgery to Prosthodontia. March 9 to May 28, 1960. Dr. Irving Salman.

Oral Tumors. March 9 to May 28, 1960. Dr. Frank S. Butler.

Maxillofacial Injuries. March 9 to May 28, 1960. Dr. William F. Harrigan.

Pain Syndromes of the Face. March 9 to May 28, 1960. Dr. Clyde B. Kayne.

Pathology. March 9 to May 28, 1960. Drs. Vincent S. Palladino and Leslie I. Lukash.

High-Speed Instrumentation. March 11 to June 3, 1960, 1 to 4 P.M. Fridays. Dr. Arthur H. Morrison and staff.

Elastic Impression Techniques. March 11 to April 15, 1960, 1 to 4 P.M. Fridays. Dr. Arthur H. Morrison and staff.

Immediate Dentures. March 11 to May 6, 1960, 9 A.M. to noon Fridays. Drs. Sidney I. Silverman, George A. Buckley, and associates.

Further information on any of the courses can be obtained by writing to Director, Postgraduate Division, College of Dentistry, New York University, 421 First Ave., New York 10, New York.

REVIEWS OF THE LITERATURE

BOOKS RECEIVED

Books received are acknowledged in this department, and such acknowledgment must be regarded as a sufficient return for the courtesy of the sender. Selections for review will be made in the interests of our readers and as space permits.

The Mouth: Its Clinical Appraisal. A. B. Riffle, D.D.S. Philadelphia, 1959, J. B. Lippincott Company. 118 pages, 22 illustrations. Price, $3.50.

Laboratory Manual of Biological Chemistry for Students of Dentistry. Walter C. Hess, Ph.D., and Joseph C. Muhler, Ph.D. St. Louis, 1959, The C. V. Mosby Company. 118 pages. Price, $2.25.

In the Dentist's Office. G. Archanna Morrison. Philadelphia, 1959, J. B. Lippincott Company. Second edition, 280 pages. Price, $7.50.

A Manual of Oral Embryology and Microscopic Anatomy: A Textbook for Students in Dental Hygiene. Dorothy Permar, B.S., M.S., Associate Professor of Dentistry, College of Dentistry, The Ohio State University, Columbus, Ohio. Philadelphia, 1959, Lea & Febiger. Second edition. 121 pages, 59 illustrations. Price, $5.50.

General Pathology and Bacteriology for Dental Students. Ronald L. Bishton, M.D. Baltimore, 1959, Williams & Wilkins Company. 317 pages, 111 illustrations. Price, $8.50.

ABSTRACTS OF CURRENT LITERATURE

Exfoliative Cytology Applied to the Detection and Treatment of Head and Neck Cancer.

H. C. Sandler, H. R. Freund, and S. S. Stahl. Surgery **46**: 479, September, 1959.

Scrapings were taken directly from oral lesions smeared on glass slides, fixed, and stained as recommended by Papanicolaou.*

The authors feel that exfoliative cytology as a screening technique has proved useful when the appearance of a primary tumor is not very suggestive of malignancy.

Gingivitis Caused by Histoplasma Capsulatum. Y. Methot, F. Blank, and A. M. Masson. Canad. M. A. J. **79**: 836, Nov. 15, 1958.

A man, 57 years of age, was admitted to the hospital with the complaint of headaches and gastrointestinal symptoms.

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*Papanicolaou, G. N.: Atlas of Exfoliative Cytology and Supplement, Cambridge, 1954, Harvard University Press.

Examination of the oral cavity revealed the presence of a mucosal lesion, measuring 2 by 1 cm., of the maxilla. A biopsy was done and reported as having cells belonging to the histoplasma group.

Tissue was taken for culture and inoculated on different media. Growth at room temperature became visible after five days. A diagnostic report of *Histoplasma capsulatum* was submitted.

Careful studies of the lesion of the oral mucosa led to a diagnosis of generalized histoplasmosis.

Anaesthesia in General Practice. Alan B. Noble. Canad. M. A. J. **80**: 131, Jan. 15, 1959.

The author asks the question: "How often are we asked for 'just a whiff' or 'just a bit of Pentothal,' and how often does the consequent inadequate anaesthesia result in disturbing episodes?"

The following factors are stressed: the maintenance of a clear airway, four-hour pre-anesthetic fasting, discreet premedication, adequate anesthesia, and the fact that there is no such thing as a minor anesthetic.

Familial White Folded Dysplasia of the Mucous Membranes. E. V. Zegarelli, F. G. Everett, A. H. Kutscher, J. Gorman, and N. Kupperberg. A. M. A. Arch. Dermat. **80**: 97, July, 1959.

The authors believe that some children are born with white folded dysplasia of the mucous membranes and that it is of a relatively mild nature, reaching its full severity and extent in adolescence. Histologic studies reveal a marked thickening of the epithelium, parakeratosis, and acanthosis.

The lesions, when present in the oral mucosa, are characterized by a white folded dysplasia coupled with diffuse dyskeratosis of the oral mucous membranes. No treatment is offered.

The Basal-Cell Nevus: Its Relationship to Multiple Cutaneous Cancers and Associated Anomalies of Development. J. B. Howell and M. R. Caro. A. M. A. Arch. Dermat. **79**: 67, January, 1959.

Frequent associated anomalies of development, including dental follicular cyst of the maxilla and mandible, are reported.

In one reported case it is stated: "During the past few years six dentigerous cysts were removed from her mandible and maxilla."

In another case report, "In 1933 a cyst of the left mandible was removed" and in "1951 a dentigerous cyst was removed from the angle of the left mandible."

The authors state: "The presenting complaints in patients with this syndrome may be caused by cysts of the jaw or maxilla, although occasionally enlargement of a cutaneous lesion or its ulceration will cause the patient to seek medical attention."

Results of Treatment of Squamous-Cell Carcinoma Arising in Mandibular Gingiva. John B. Erich and L. V. Kragh. A. M. A. Arch. Surg. **79**: 112, July, 1959.

During the ten-year period ending in 1954, treatment of patients with squamous-cell carcinoma of the mandibular gingiva at the Mayo Clinic was individualized.

Prophylactic dissection of the neck has been employed in the treatment of occult metastatic tumors in cervical nodes arising from carcinoma of the lower gingiva. Each patient's case was dealt with as an individual problem, and the application of such dissection was less rigid than it was for lesions of the anterior part of the tongue. The age of the patient and his general health, as well as the size and histologic grade of malignancy of the primary mandibular lesion, were factors considered in employing prophylactic dissection of the neck. During the early years of the study, dissection of

the upper part of the neck (submental, submaxillary, and upper deep-jugular nodes) was done in addition to the standard radical block dissection. Dissection of the upper part of the neck usually was done bilaterally if the lesion was near the midline. Also, during the early years of the study, block dissection of the cervical nodes without sacrifice of the internal jugular vein or the sternocleidomastoid muscle occasionally was employed.

TABLE I. SQUAMOUS-CELL CARCINOMA ARISING IN THE MANDIBULAR GINGIVA: INITIAL TREATMENT OF THE PRIMARY LESION OF THE MAYO CLINIC

TREATMENT	PATIENTS
Excision (includes excision as part of a composite operation)	23
Electrocoagulation	64
Electrocoagulation or excision plus radium or radon	15
Radium or radon, or roentgen therapy, or both	14
No treatment (primary believed controlled)	2
Total	118

During the later years of the study, the standard radical block dissection of the neck was employed more frequently and eventually was included as part of a composite operation. Prophylactic roentgen therapy to the neck was used occasionally during the early years of this study only. Inoperable cervical metastatic tumors or cervical metastatic lesions occurring in aged, poor-risk patients usually were treated with interstitial radon seeds or external roentgen therapy or both.

TABLE II. SQUAMOUS-CELL CARCINOMA ARISING IN THE MANDIBULAR GINGIVA: SURVIVAL RATES

PERIOD (YRS.)	PATIENTS		LIVED BEYOND INDICATED PERIOD	
	TOTAL	TRACED	NUMBER	PER CENT
3	118	107	67	62.6
5	94	87	45	51.7

T. J. C.

Treatment of Squamous-Cell Carcinoma of the Floor of the Mouth. J. B. Erich and L. V. Kragh. A. M. A. Arch. Surg. **79:** 106, July, 1959.

The authors describe "the floor of the mouth" as that region between the lateral border of the tongue and the mandibular alveolus.

The study was undertaken to determine the end results of treatment of all patients with squamous-cell carcinoma of the floor of the mouth seen at the Mayo Clinic, from 1945 through 1954.

TABLE I. SQUAMOUS-CELL CARCINOMA OF THE FLOOR OF THE MOUTH: INITIAL TREATMENT OF THE PRIMARY LESION AT THE MAYO CLINIC

TREATMENT		PATIENTS
Excision (includes excision as part of a composite operation)		32
Electrocoagulation		36
Excision or electrocoagulation plus radium or radon		18
Radium or radon, or external irradiation, or both		13
No treatment		3
Primary controlled	2	
Died before treatment	1	
Total		102

During this ten-year period, patients with squamous-cell carcinoma of the floor of the mouth were managed on an individual basis, the treatment not being restricted to any one method. During the early years of the study, if the primary lesion was considered removable, it was usually extirpated by electrosurgery. If the lesion was small and well localized, it usually was excised with a margin of normal surrounding tissue.

TABLE II. SQUAMOUS-CELL CARCINOMA OF THE FLOOR OF THE MOUTH: SURVIVAL RATES

PERIOD (YRS.)	PATIENTS		LIVED BEYOND INDICATED PERIOD	
	TOTAL	TRACED	NUMBER	PER CENT
3	102	94	57	60.6
5	73	65	30	46.2

In some of the cases in which the primary lesion was treated by electrocoagulation, block dissection of the neck and ligation of the external carotid artery preceded treatment of the oral lesion. In some instances, depending on the extent of the lesion, the histologic grade of the tumor, or a question of incomplete removal of the lesion, supplementary interstitial radium or radon seeds were used. More extensive, high-grade, less localized lesions usually were treated by radium or radon seeds, roentgen therapy, or both. During the later years of the study, composite operations occasionally were employed.

T. J. C.

Treatment of Carcinoma of the Tongue: End Result in One Hundred Sixty-Eight Cases. O. H. Beahrs, K. D. Devine, and S. W. Henson, Jr., A. M. A. Arch. Surg. **79:** 399, September, 1959.

The authors feel that cancer of the tongue is best treated by wide excision or hemiglossectomy, except in the case of lesions that are inoperable or are situated at the base of the tongue and are of a high degree of malignancy. These may be better treated by irradiation. Although the authors do not routinely recommend radical dissection of the neck at the time of treatment of the primary lesion in all cases of carcinoma of the tongue, they favor it in all cases in which cervical lymphadenopathy is present and in many cases in which there are factors that might influence the prognosis. In other words, if a lesion is situated on the anterior part of the tongue, if it is small (0 to 2 cm. in diameter), if it is of Grade 1 or Grade 2 malignancy, and if there is no lymphadenopathy, then dissection of the neck usually would not be advised. However, if the tumor is larger and of Grade 2, Grade 3, or Grade 4 malignancy, with or without lymphadenopathy, dissection of the neck would be considered part of the definitive treatment for the lesion and should be done at the same time.

Although the hospital mortality rate was 3.6 per cent in this series, it should be reducible by the use of prophylactic agents, such as antibiotics and anticoagulants, and the free use of tracheotomy. The morbidity of patients operated on is much less than that of patients treated by irradiation or electrocoagulation.

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